THE EFFECTS OF COGNITIVE STYLE AND LOCUS OF INSTRUCTIONAL CONTROL STRATEGIES ON LEARNER ACHIEVEMENT AND ANXIETY IN AN INTERACTIVE VIDEODISC LESSON ON STRUCTURE AND FUNCTION OF THE HUMAN BRAIN

By

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by

Vicki Mari Diaz

This dissertation is dedicated to my parents
Leslie and Lillian Harrell
with much love.

If ever a Mom had a warm, loving touch,
It's the wonderful Mother who taught me so much.

If ever a father was thought the world of,
It's the wonderful Dad I look up to and love.

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Abstract of Dissertation Presented to the
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The purpose of this study was to investigate the effects of cognitive style and locus of instructional control strategies on learner achievement and state anxiety when using an interactive videodisc lesson. Second-year medical students (N = 69), randomly selected and assigned within cognitive style strata, studied an interactive videodisc lesson in neuroanatomy in one of two treatment conditions, learner control or program control. State anxiety was measured before and after lesson completion; pretest and posttest scores were obtained to measure learner achievement. Results indicated that although state anxiety increased upon completion of the lesson, there were no significant differences for state anxiety with instructional control strategy, cognitive style, learner achievement, or gender.

Pretest scores were significantly related to posttest achievement. Significant results were found for the interaction of instructional control strategy and cognitive style on learner achievement when controlling for individual differences, specifically pre-task state anxiety, grade point average, and Medical College Admission Test score.

Medical student populations have not been previously studied with regard to cognitive style, instructional control strategies, and state anxiety when using interactive video. The study results provide evidence that this population may be different from those previously studied with consideration to these variables. Specifically, state anxiety does not appear to adversely affect learner achievement in urban medical students when learning with interactive video. Further, consistent gender differences, found in the field dependence-independence dimension, were nonexistent in the medical student population studied. Additionally, cognitive style and gender seem to have no effect on state anxiety in the population studied, contradictory to prior research with other college populations. Medical students are a highly select group of graduate students with unique attributes that present challenging issues to designers of medical education courseware. This study supports prior research findings that the interaction of locus of instructional control strategies and learner attributes is critical to learner success in the rich environment provided by innovative educational

technology, and should be further explored with specific populations.

CHAPTER 1
INTRODUCTION

Emerging technological developments have increasingly found potential applications within the educational realm. Many of these new instructional innovations have captured the attention of the education professional, but few with the fervor of interactive video. Combining the versatility of the microcomputer with the visual and aural capabilities of video has created a technology believed to be unlike either component technology (DeBloois, 1982). Many educators believe that interactive video holds unique capabilities for learning and is the future of education (Harless, 1986; Reigeluth & Garfield, 1984; Wood & Woolley, 1980). Alessi and Trollip (1991) believe interactive video to be computer-based instruction enhanced by a video peripheral that allows high quality visual and aural presentations not possible if the computer were used alone. Interactivity occurs by linking the videotape or videodisc to a computer to allow interaction with the learner. The term "interactive" implies that the learner is actively engaged in the lesson and often controls the course of instructional sequence through responses to the information presented (Withrow, 1986).

Curricular uses for interactive video are numerous. Videodiscs can be used for a variety of instructional problems and settings, including education for the deaf

(Newell, Sims, & Myers, 1983), business education (Ferrier, 1982), military training (McGrane & Toth, 1990), medical education (Harless, 1986), instruction for mentally handicapped students (Malouf, MacArthur, & Radin, 1986), bilingual education (Gindele & Gindele, 1984), and traditional education (Abrams & Streit, 1986; Levenson & Morrow, 1986).

Reports of the actual success of videodisc applications have been mixed. Endorsements of the effectiveness of the instruction have been reported (Brawley & Peterson, 1983; Brown, 1992/1993; Dalton, 1986; Hannafin, Phillips, & Tripp, 1986; Ho, Savenye, & Haas, 1986; Mason, 1992; Reeves, 1986; Schroeder, 1982; Smith, Jones, & Waugh, 1986), as well as studies reporting slight or no significant differences (Brungardt, 1993; DeBloois, Woolley, & Forrer, 1981; Fowler, 1983; Hannafin & Colamaio, 1986; Holmgren, Dyer, Hilligoss, & Heller, 1979; Jiau, 1993; Larsen, 1992).

Claims for positive effects for interactive video are generally related to learning effectiveness, cost effectiveness, reduced learning time, and learner attitudes. However, Clark (1983, 1985) argues that much of this body of media research is comparative in nature and susceptible to confounding variables, such as developing experimental (computer) instruction with greater care than control (traditional) instruction, using different teachers to deliver different instructional conditions, and the effects of novelty. Clark (1983) asserts that the most significant factor in the efficacy of instruction is not the delivery medium, but the message and the instructional strategies conveyed by the medium. Many comparative studies have been conducted with instructional technologies involving the computer (Kulik, Kulik, & Cohen, 1979, 1980); however, few research studies utilizing experimental and quasi-experimental designs to compare instructional technologies have produced useful outcomes, according to Clark (1983).

Hannafin, Phillips, and Tripp (1986) agree that little empirical evidence has been published to support the effects of interactive video on learning. Many researchers now advocate a learner-based approach to the study of instructional technologies, rather than a "technology first" approach (Balson, Ebner, Mahoney, Lippert, & Manning, 1986; Clark, 1983). Maddux (1993) recommends that research in educational computing focus on "how learner and learning variables interact with teaching variables as they relate to specific dependent variables" (p. 18). Maddux (1993) further recommends an increased emphasis on experimental and quasi-experimental research investigating learner and treatment interactions.

Two variables that require further study with interactive video are locus of instructional control and the awareness of individual differences in applying technology to the instructional process. Fleming and Levie (1978) classify the difference between instruction and learning according to the locus of the activity; instruction can occur outside the individual, but learning is something only the learner can do. Interactive video can give the student control over learning strategy, allowing the student to control pace, sequence, depth of study, or style of instruction, thereby allowing for individual learner requirements.

Instructional locus of control is generally presented in two forms, externally controlled (program control) or internally controlled (learner control). With external or program control, all learners follow a predetermined path imposed by the designer. Internal control or learner control allows the individual to control the path, pace, and strategies from a range of choices embedded by the designer (Hannafin, 1984). Instructional locus of control has been studied extensively in the literature related to computer-assisted instruction, generally supporting learner control as a benefit, resulting in improved learner achievement, long-term retention, reduction of instructional time, and motivation (Carrier, 1984; Carrier, Davidson, & Williams, 1985; Snow, 1980). Mixed support for the benefit of learner control was reported to show equal, or in some cases, lower achievement gains (Fisher, Blackwell, Garcia, & Greene, 1975; Gay, 1986). There are few studies related to locus of control strategies and interactive video. Balson, Manning, Ebner, and Brooks (1985) found evidence of support for learner controlled interactive videodisc instruction, whereas Milheim and Azbell (1988) report mixed results. An interesting finding across several studies (Campbell, 1964;

Fry, 1972; Hannafin, 1984; Snow, 1980) is that higher ability students were more adept at using learner control than were lower ability students. Snow (1980) and Carrier (1984) argue that additional research is needed to determine which types of students will benefit from having control over instructional strategies.

In an effort to address individual differences, educators have attempted to match individual learning styles to appropriate computer technology. For example, researchers have studied whether learner control accommodates individual differences more effectively than program control. Results are contradictory (Judd, 1972; Lahey, Hurlock, & McCann, 1973; Steinberg, 1977; Tennyson, 1980) but generally support that learner control should be the instructional design for subjects requiring minimal prerequisite knowledge, and program control should be used for high task demands or low student aptitude. Rotter (1966) points out that there are considerable individual differences in the perception of control that require further study, since each learner has a preferred method of processing information. This preference is often referred to as the individual's cognitive style. A student's cognitive style is determined by how he or she perceives, encodes, stores, and retrieves information (Carrier, 1984). Sperry (1972) suggests that learning style differences are based upon variations of cognitive structure, and this personal style of learning is a key factor in the educational process.

The most widely researched area of cognitive style is field-dependence and field-independence, which is the extent to which surroundings influence the perceptions of a student (Smith, 1985). Highly field-independent learners tend to restructure a stimulus when it is beneficial to do so, applying their own strategies for modification; whereas field-dependent learners are less able to organize information internally and need structured mediation to facilitate performance (Carrier, 1984). Snow in 1980 and later Williams in 1993 state that there is a lack of empirical knowledge with regard to which types of learners should be granted control, and under what conditions. One factor that may predict a learner's behaviors under different locus of control strategies is cognitive style. Wittrock and Farley (1989) state that, in order for learning to occur, learners must be mentally active in the learning process. Interactive video has the potential to mentally engage the learner by directly involving them in learning in a way that is amenable to their cognitive style. However, a lack of research has led to development of instruction with little regard for learner characteristics. Reeves (1993) calls for future studies on how to best design interactive instruction based on the interaction of locus of control strategies and learner attributes using theoretical and methodological scientific approaches.

Previous research with computer-assisted instruction and programmed instruction has also shown anxiety to be an important learner attribute that effects learning outcome (Clark, R. E., 1984; Gallagher, O'Neil, & Dick, 1971; Seiber, O'Neil, & Tobias, 1977). Several studies show that learner anxiety can decrease achievement when learning with computers (Cambre & Cook, 1985; Leherissey, O'Neil, & Hansen, 1971; O'Neil, Spielberger, & Hansen, 1969). Spielberger (1966) believes that as anxiety can interfere with the learning process, it is important to determine in finer detail the exact nature of the relationship between anxiety and learning. Spielberger's (1966) theory of anxiety includes two dimensions, state, which is a transitory characteristic operating in a specific condition, and trait, a relatively permanent personality variable. Cambre and Cook (1985) discuss the importance of identifying, measuring, and preventing or remediating anxiety in order to facilitate successful education. R. E. Clark (1984) suggests that instructional anxiety be circumvented through design, as efforts to alleviate anxiety have largely failed.

Educational researchers have examined the effects of anxiety and instructional control strategies on learner achievement (Coorough, 1990; Gallagher, O'Neil, & Dick, 1971; Hansen, 1972). In general, these researchers have found that providing learners with control did not necessarily increase achievement but reduced anxiety levels. However, there is a lack of empirical evidence to better understand the relationships between anxiety, cognitive style, and locus of control strategies.

Interactive video can provide a rich technological environment, when one considers sound instructional design (Roblyer, 1988) and the attributes the learner brings to that environment (Glaser & Bassok, 1989). Hannafin and Phillips (1987) describe the need for further research with interactive video that is focused on human information processing, rather than on the technology of the system. We as educators need to understand the role of technology in supporting the learner, rather than attempting to adapt the learner to the technology.

Statement of the Problem

The problem under investigation in this study was to determine the interaction effects of cognitive style and locus of instructional control strategies (learner control or program control) on learner achievement and anxiety when using an interactive videodisc lesson.

Specific questions related to the problem are as follows:

1. Does anxiety change from pre- to postinstruction depending on locus of instructional control strategy?

2. Is there a relationship between the interaction of locus of instructional control strategy and cognitive style on pre-task anxiety?

3. Is there a relationship between pretest scores and posttest achievement scores?

4. Is there a relationship between pre-task state anxiety and posttest achievement?

5. Is there a relationship between locus of instructional control strategy and posttest achievement?

6. Is there a relationship between the interaction of locus of instructional control strategy and cognitive style on posttest achievement?

7. Is there a relationship between the interaction of cognitive style and locus of instructional control strategy, on posttest achievement when controlling for pre-task anxiety?

8. Is there a relationship between the interaction of gender and cognitive style on posttest achievement?

9. Is there a relationship between the interaction of cognitive style and gender on pre-task anxiety?

10. Is there a relationship between the interaction of locus of instructional control strategy and cognitive style on posttest achievement when controlling for GPA, MCAT score, and pre-task anxiety?

11. Is there a relationship between the interaction of locus of instructional control strategy and cognitive style on pre-task anxiety when controlling for GPA and MCAT score?

12. Which locus of instructional control strategy requires greater time-on-task to lesson completion?

Justification for the Study

There is a compelling need to discover the specific relationships between learner attributes and the effectiveness of interactive video instruction. Goodman

(1978) emphasizes the need for discovery of systematic relationships when he states,

> when [instructional systems] are able to jointly take into consideration not only the ways in which learner's cognitive structures are formed and changed but also the ways in which student learning styles, aptitudes, and media preferences differ and affect learning, then a new dimension, a 'quantum leap' in instruction may well have been achieved. (pp. 16-17)

True individualization is brought to the instructional process when instructional designers understand the impact of individual differences. An extensive search of the literature found no studies examining state anxiety and interactive video instruction, and only five studies that consider cognitive style and interactive video instruction.

There has also been a lack of research that considers the medical student as an individual learner and a lack of evidence to determine the instructional strategy necessary to support the individual to optimize cognitive and affective performance. As medical education research studies have not examined learner anxiety when using interactive video and studies reporting learner achievement are poorly designed, it is necessary to examine individual differences among medical students in well-designed research studies to determine effects of instructional methods on variables such as achievement and learner anxiety.

The computer and its technologies are empowering human intellect and restructuring education as did the printing press. The United States National School Boards Association, Carnegie Commission, and the United States National Task

Force on Education have called for the nation's schools to adopt a technology-based curricula as a means to increase educational productivity (Nelson & Watson, 1991). The Office of Technology Assessment (1988) completed for the United States Congress an indepth report on the future impact of technology in education, recommending the federal government take a more active role if interactive technology is to realize its potential for improving education. To meet these educational demands, the United States National Education Association (1989) recommends that the learning environment be restructured to provide students with the enriched and individualized instructional opportunities that new technologies offer.

Reigeluth and Garfield (1984) believe the interactive videodisc to be the most significant technology in the instructional sciences. D. J. Clark (1984) reports that the variety of visual and auditory learning stimuli present in interactive video could dramatically improve learning. Schaffer and Hannafin (1986) advise that the interactive feature of interactive video can improve short-term recall and improve retention. Interactive instructional technologies have the tremendous potential to adapt to individual differences in learners (Buttery & Parks, 1988). The interactive videodisc is also capable of allowing the learner the opportunity to select and sequence instructional content and strategies (Hannafin & Phillips, 1987). This delivery system can create endless possibilities for cognitive diversity and instructional diversity, yet there exists little empirical evidence to support its use within education.

Suggestions for future research with interactive video include consideration of learner variables (Balson, Ebner, Mahoney, Lippert, & Manning, 1986), more specifically cognitive style (Smith, 1985). Determination of the presence or absence of anxiety and whether the anxiety facilitates or debilitates academic performance is an important research agenda (Alpert & Haber, 1960). Carrier (1984) and Snow (1980) conclude that additional research is needed to determine which types of learners will benefit from having control of the instructional environment and what types of control are beneficial to the learner. Hannafin (1984) adds that the interaction of learner control with individual variables has not been extensively studied.

Interactive videodisc technology has been recommended for a variety of instructional problems and settings, and has had particular initial success in some disciplines, most notably military and medical education. With regard to professional education of the physician, the Association of American Medical Colleges (Muller, 1984) investigated the potential of interactive video and determined that this medium could provide effective instructional delivery for medical education. More importantly, this report recommends that medical faculties should identify students who have the ability to learn independently and should provide opportunities to develop this skill further. The report calls for well-designed interactive video that allows the medical student to form hypotheses and develop complex decision-making abilities.

There have been several interactive videodisc studies in medical schools, generally comparative in nature, which found a positive effect for learning achievement (Culbert, Cantelmo, Stafford, & Allan, 1989; Jones & Schoultz, 1990; Sajid, Ewy, Felner, Glessner, Gordon, Mayer, Shub, & Waugh, 1990). However, the majority of studies in the medical education literature have been poorly designed and rarely report reliability or validity data for the criterion measures.

After scrutiny of the comparative nature of instructional technology research, Clark (1983) suggests that effect size was due to confounding variables such as novelty and aggressive design of the treatment condition. Clark (1983, 1985) further suggests that instructional media research not compare traditional instructional methods to technology-based methods. Jonassen (1988) suggests that instructional technology research examine the interaction of learner attributes with instructional design strategies. Helping medical students improve learning, and thus facilitate the acquisition of information, is of utmost importance to every medical school. There exists a critical need to investigate the use of interactive video in medical education with emphasis on the individualization of learning and the control strategies necessary to support the learner. This research study attempted to determine the interaction effects of cognitive style and locus of instructional control strategies on learner achievement and anxiety when using an interactive videodisc lesson.

Hypotheses

On the basis of existing research, it was hypothesized that learners would benefit differentially from two locus of instructional control strategies. It was also hypothesized that learners' state anxiety levels would be dependent upon locus of instructional control treatment and may impact learning achievement. It was further hypothesized that the interactions of cognitive style, gender, GPA, and MCAT scores with locus of instructional control strategy may result in differential achievement and state anxiety levels. To test these hypotheses an experimental group design was developed. In order to compare the data provided by the study groups for statistical significance the following null hypotheses were identified:

H1: There is no significant interaction between locus of instructional control strategies (program control or learner control) and occasion (pre-task or post-task) that affects state anxiety levels.

H2: There is no significant relationship between the interaction of locus of instructional control strategies (program control or learner control) and cognitive style with post-task state anxiety.

H3: There is no significant relationship between pretest scores and posttest achievement scores.

H4: There is no significant relationship between pre-task state anxiety levels and posttest achievement.

H5: There is no significant relationship between locus of instructional control strategy and posttest achievement.

H6: There is no significant relationship between posttest achievement and the interaction of locus of instructional control strategy and cognitive style.

H7: After controlling for pre-task anxiety, there is no significant relationship between posttest achievement and the interaction of cognitive style and locus of instructional control strategy.

H8: There is no significant relationship between posttest achievement and the interaction of gender and cognitive style.

H9: There is no significant relationship between the interaction of cognitive style and gender on pre-task anxiety.

H10: After controlling for GPA, MCAT score, and pre-task anxiety, there is no significant relationship between posttest achievement and the interaction of locus of instructional control strategy and cognitive style.

H11: After controlling for GPA and MCAT score, there is no significant relationship between pretest anxiety and the interaction of locus of instructional control strategy and cognitive style.

H12: There are no significant differences between locus of instructional control strategies in time-on-task to lesson completion.

Assumptions

The results of this research effort are presented on the basis of several assumptions. It was assumed that

1. Subjects completed to the best of their ability the Group Embedded Figures Test to determine cognitive style;

2. Subjects responded honestly to the State portion of the State-Trait Anxiety Inventory;

3. Subjects completed the pretest and posttest honestly and to the best of their ability;

4. Subjects followed directions for completion of the interactive videodisc lesson according to the treatment condition to which he or she was randomly assigned.

Limitations

The researcher had no control over the learner's honest and serious participation in completing study assessments which included the cognitive style assessment, the pre-task and post-task state anxiety measurements, and the pretest and posttest measurements. Further, the researcher had no control over the subject's honest and serious participation in completing the interactive video instructional treatments.

Delimitations

This research study was delimited to

1. Male and female second-year medical students;

2. Students enrolled in the School of Medicine at Wayne State University.

Definition of Terms

The following terms are defined to clarify their use in this study:

Anxiety is a psychological characteristic consisting of an unavoidable, unpleasant experience having both negative physiological and behavioral effects often interfering with learner performance in instructional situations (Spielberger, 1966).

Cognitive style refers to how a learner perceives, encodes, stores, and retrieves information (Carrier, 1984).

Computer-assisted instruction is an instructional method based upon the two-way interaction of a learner and a computer with the purpose of human learning and retention. The computer contains a stored instructional program designed to inform, guide, control, and test the student until a prescribed level of proficiency is attained (AECT, 1977).

Interactive video is an instructional technology that incorporates computer-based instruction enhanced by a video peripheral that allows high quality visual and aural presentations (Alessi & Trollip, 1991).

Learner control is a lesson control strategy that permits learners to make decisions about program activities and procedures according to individually perceived needs (Hannafin & Colamaio, 1987).

Locus of instructional control strategies are instructional design options that range along a continuum from complete learner control of lesson sequence, pace, feedback, and other lesson features to total imposed control of lesson activities by the designer (Hannafin & Colamaio, 1987).

Program control is a lesson control strategy where the program's designers have imposed control of lesson activities. Learners generally follow a predetermined instructional sequence and are required to attain a minimum level of mastery (Hannafin & Colamaio, 1987).

State anxiety is a transitory anxiety situation characterized by subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system (Spielberger, 1966).

Trait anxiety refers to a relatively stable personality characteristic implying acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively nondangerous circumstances and to respond to these circumstances with an intensity which is disproportionate to the magnitude of the objective danger (Spielberger, 1966).

Organization of Remaining Chapters

The remainder of this study was organized into four chapters. Chapter 2 contains a review of the literature related to the research problem specified in this chapter.

The research methodology, experimental design, and the analysis procedures are described in Chapter 3. The results and analyses of data collected in the study are presented in Chapter 4. Chapter 5 contains a discussion of the research results and conclusions, recommendations for future research, and a summary of the study.

CHAPTER 2
REVIEW OF THE LITERATURE

The purpose of this study was to determine the interaction effects of cognitive style and locus of control strategies on learner achievement and anxiety when using an interactive videodisc lesson. This chapter includes a review of the literature related to the study variables. Chapter 2 begins with a discussion of interactive video and is further divided into the following sections: (a) cognitive style, (b) locus of control, and (c) anxiety. Subsections further review each main section.

Interactive Videodisc

Wittrock and Farley (1989) state that in order for learning to occur, learners must be mentally involved in the learning process. Computer-based instructional systems can mentally engage learners by involving them directly in the process of learning. Interactive video offers the added dimension of video, which can surpass computer-based systems, due to the ability to involve the learner in the lesson and engage the learner in an active two-way dialogue. Iuppa and Anderson (1988) believe that well-designed interactive video lessons appeal to learners because of the "built-in" invitation to interact with visuals, enabling them to interrupt, identify, sequence, and select from alternative actions. Students can interrupt or repeat visual scenes, stop or change sequences, practice with concepts, select options, and view consequences visually and dramatically. Gindele and Gindele (1984) assert that the interactive videodisc "may become one of the most revolutionary developments in the history of entertainment, information processing, education, and training" (p. 97).

Interactive Technology

Interactive video is a relatively new instructional technology that incorporates computer-based instruction capabilities, for example, information management and decision-making, with the capabilities of video to produce high quality visual and aural presentations (Alessi & Trollip, 1991; DeBloois, 1982). Interactive video has the potential to provide simulations without expensive equipment, place learners in dynamic problem-solving situations, and provide individualized training and feedback. There is some disagreement in the literature as to whether interactive video is an entirely new medium with characteristics unlike its components of video and computer mediums, as stated by DeBloois (1982), or rather primarily video instruction with the computer as a control device as stated by Iuppa (1984).

The concepts of interactive techniques originated with the development of the teaching apparatus machine by Pressey in the early 1920s, and continued with Skinner's teaching machine and programmed instruction in the late 1950s (Floyd & Floyd, 1982). These concepts promoted the development of computer-assisted instruction in the early 1960s, which eventually led to the technological combination of microcomputer and videotape, resulting in interactive video instruction.

Pohchin (1990) believes that technology may be the "catalyst for rethinking teaching and learning, redesigning the pedagogic strategies of the teacher, and broadening the context within which learning can occur" (p. 315). Interactive technology has the capability of bringing several methods of information, including audio, video, text, graphics, and sound together to create new and exciting opportunities for learning. Integrating these components presents a considerable challenge for interactive videodisc design.

Optical videodisc systems, employing the use of laser technology to read the data, are very versatile. The primary advantage of the interactive videodisc is the ability to present information and involve the learner in a way that the computer or videotape alone cannot do. For example, in medical education, interactive video allows the student to assist a pediatrician in examining a child or observe a surgeon during an operation. In law education, interactive video permits the student to observe a courtroom in action or play the role of the defense attorney. In these simulations, the student can ask questions, solve problems, replay segments, receive instruction and individualized feedback, freeze frames for further study, and monitor progress.

Interactive video allows the simulation to become more realistic.

There are several instructional advantages associated with interactive video that are related to the technology of the medium. Because data can be read nonlinearly, information from any one of the 54,000 frames can be retrieved rapidly and in any order, promoting fast and constant interaction. Random access allows branching within the instructional program, so that any lesson can be individualized. Kemph (1981) views this feature of interactive video as the most important related to education, with the potential to profoundly affect the way students learn.

A second major advantage of the optical videodisc is the tremendous storage capacity. Wood and Woolley (1980) state that this technology surpasses all other storage media, including magnetic computer discs, due to the capability of each videodisc to store more than 13 billion bits (gigabits) of information. Videodiscs can store multiple media formats, including audiotapes, cassettes, phonograph records, television, videotapes, motion pictures, filmstrips, slides, film loops, overhead transparencies, microforms, and books, within all of the 54,000 frames per side.

Gindele and Gindele (1984) identify the visual resolution and fidelity of information obtained from videodiscs as advantageous for instructional purposes. The quality of motion video and still images is better than those obtained from videotape recorders and players, and sounds and digitized voices are preserved almost perfectly. Butler (1981) believes that the visual resolution has the potential of being six times as dense as the video of today and will not fade as do photographs and film materials.

The videodisc is also an excellent medium for freeze and still frame display (Alessi & Trollip, 1991). Freezing is when a student pauses a motion image. For example, if a medical student is studying a surgical technique that requires a complicated suturing sequence, the student can press a "stop" button to freeze the motion to study the position of the surgeon's hands and the instruments involved. Next, the student could press a "step" button to move ahead to the next image in the sequence, one thirtieth of a second later. This cannot be done well with videotape because as the videotape is paused, the image degrades significantly, and over time the tape wears down and destroys the image. In contrast to freeze frame, a still frame is a single stationary picture that is not in a motion video sequence, for example, a photograph, a page from a textbook, or diagram. A videodisc may use only a few still images to supplement instruction or may use still frames extensively (Alessi & Trollip, 1991).

With the appropriate hardware, the videodisc may be used interactively by the student. Because the disc and hardware may be used differentially, a classification system was adopted to distinguish different amounts of levels of interactivity (Hofmeister, Engelman, & Carnine, 1986). Level-0 describes a videodisc program played linearly, from start to finish, for example, a movie or an educational presentation. The user does not interact in any way; therefore, zero signifies no interactivity. Level-1 describes a videodisc player that has additional functions for searching, slow and fast motion, freeze frame, and scanning, controlled manually with a hand controller. An instructor may use a Level-1 player to display visual and aural information from a database to an entire class (Daynes & Butler, 1984). An example of a Level-1 program is The First National Kidisc (Green, 1981). This videodisc contains several educational activities for children such as identifying flags, learning sign language, and making paper airplanes. The child must use a printed catalog for information as to contents and location of topics on the disc (Alessi & Trollip, 1991).

Level-2 players have all the functions of a Level-1 player plus a built-in microprocessor. The user still interacts via the hand controller but does not have to know the location of information, as the videodisc can display menu options (Grabowski, 1989). An example of a Level-2 program is Producing Interactive Videodiscs (Minnesota Mining & Manufacturing, 1982). Also, Walt Disney World in Orlando, Florida, utilizes a Level-2 videodisc player in kiosks that allow visitors to select areas of interest. If, for example, the tourist selects "restaurants," a selection of places to dine will appear on the screen. The tourist may then choose a restaurant, "visit" the restaurant via videodisc movie, examine the menu, and then, once a decision is made, make a reservation with the host appearing on the screen (Clark, R. E., 1984).

A Level-3 player has all the capabilities of a Level-2 player but is also connected to a microcomputer. The user can interact via the computer keyboard or with any input device connected to the computer, such as a mouse, light pen, or touch screen. The system can display text, graphics, and motion video complemented by stereo sound. Level-3 programs offer the most flexibility and are the most powerful form of interactive video (Daynes & Butler, 1984). Level-3 videodiscs are often called intelligent videodiscs, due to enhanced options for structuring lessons, posing questions, and responding to learner input (Elting & Eisenbarth, 1986). An example of a Level-3 program is Assessment of Neuromotor Dysfunction in Infants (Blackman, Lough, & Huntley, 1984). Recently, many instructional designers have added another classification, Level-4, which means any Level-3 program with additional hardware such as a second or third videodisc player, a CD-ROM drive, or any further electronic equipment (Alessi & Trollip, 1991).

Interactive Video Research

Interactive video is the latest instructional innovation studied with experimental and quasi-experimental research designs which compare one instructional technology with another. Comparative research designs have dominated research with computer-based instruction and interactive video research has been subjected to this same model of evaluation. Hoban, in 1958, and more recently Clark, in 1983, have cautioned that comparative research designs have produced little differential effectiveness of instructional technologies and should be abandoned. Reeves (1986) concurs and reports that few comparative research studies have reported any statistically significant differences, and those that do generally favor the technological innovation. This conclusion supports Clark's (1983) thesis that novelty of one treatment condition, for example interactive video compared to lecture, produces a flawed research design. McNeil and Nelson (1991) conducted a meta-analysis of interactive video research studies and found an overall mean achievement effect of .530 in 63 studies, indicating that interactive video can be an effective form of instruction. However, the researchers included comparative studies where interactive video instruction was compared to a traditional non-interactive group, due to the small number of instructional design studies that utilized interactive video as its own comparison.

Literature on research using interactive video is increasing; however, the majority of studies continue to be comparative in nature. For example, Levenson and Morrow (1986) studied cognitive and affective responses of college students to a lesson on smokeless tobacco, comparing videotape to interactive videodisc. Results showed that the interactive videodisc group had significantly higher cognitive achievement, were more willing to promote cessation of smokeless tobacco users, and reported the highest degree of satisfaction with the learning environment.

Malouf, MacArthur, and Radin (1986) investigated the use of interactive video to teach on-the-job social skills to learning disabled adolescents, compared with use of workbook instruction. The interactive video group scored significantly higher on the posttest than the workbook group. Abrams and Streit (1986) report that an interactive videodisc group learning basic photography skills show significantly higher achievement and more positive attitudes than the comparison group using linear videotape. However, the interactive videodisc group had significantly longer instructional times than did the videotape group.

Learning to prepare and administer an intramuscular injection was the learning task for paramedics randomly selected and assigned to an interactive videodisc group or videotape group (Balson, Ebner, Mahoney, Lippert, & Manning, 1986). The interactive videodisc group had significantly higher achievement in all variables measured, lower stress, greater satisfaction with training, and faster training time. The researchers reported a savings of 30% instructional time with interactive videodisc. Dalton (1986) studied achievement and attitude scores of junior high students to a lesson on safety rules, comparing linear videotape to computer-assisted instruction to interactive videodisc. Results indicated that the computer-assisted instruction and interactive videodisc groups had significantly higher achievement on the performance measure than the linear videotape group. With regard to attitude, the interactive video group reported the most positive attitudes with regard to instructional method.

Fry (1992/1993) directed a study comparing interactive video to audiotape. Music students registered for a conducting class were randomly assigned to either interactive video as a supplement to musical scores or audiotapes as a supplement to musical scores. Results after posttest and a conducting performance evaluation found that the interactive video group achieved better conducting skills than did the audiotape group. Fry (1992/1993) concludes that interactive video is a valuable tool in teaching a movement skill such as conducting.

Schaffer and Hannafin (1986) studied the effects of progressive interactivity on achievement and instructional time. Subjects were randomly assigned to instructional treatments consisting of linear video, linear video plus questions, linear video plus questions plus feedback, or fully interactive video. Results determined that as instruction became more interactive, learning increased, with the linear video group demonstrating the least achievement and the interactive video group gaining the most achievement. The instructional time needed to complete the lesson was greatest for the interactive video group and lowest for the linear video group. Therefore, the amount of interactivity in the instruction and the instructional time were negatively correlated.

Brown (1992/1993) studied behavioral changes in students after participating in an AIDS curriculum, either through a traditional classroom approach or with interactive video. Results found that females who participated with the interactive video curriculum were more likely than females in the traditional classroom setting to plan to abstain or to practice safer sex at their next sexual encounter. Further, the researcher determined that students in the interactive video treatment were more likely to feel vulnerable to the consequences of their sexual decision-making and more likely to perceive the sexual behaviors of their peers as riskier.

These comparative research studies support Reeves' (1986) contention that evaluations of this type generally find either no significant differences or differences favoring the newest technology. Clark (1983) has proposed that technological media are merely "delivery vehicles for instruction and do not directly influence learning" (p. 453) and advocates that future research with media focus on characteristics of instructional methods and learner variables.

Research with interactive video that is noncomparative in nature is scarce, with only a few studies available. Hannafin, Phillips, and Tripp (1986) investigated the effects of instructional design strategies of orienting activities, access times, and processing activities on achievement in an interactive videodisc lesson on the lives and art of the Renaissance and Baroque painters. Orienting activities were statements designed to prepare the learner for the forthcoming lesson content, directing the learner to pay attention to important information. Access time was the amount of time allotted to the student to utilize the orienting activity. Subjects who received orienting activities were given either 5 or 20 seconds access time to utilize the orienting information. Processing activities were statements guiding the student to think about the information just presented. Subjects receiving processing activities were given as much time as needed to process information before continuing the lesson. The interactive video lesson required 45 minutes to complete, with all subjects receiving the same instruction in the same sequence. Subjects were volunteer college students randomly assigned to one of the treatment combinations, consisting of between subjects factors of orienting activity (activity or no activity), access time (5 seconds or 20 seconds), and processing activity (guided or not guided). The research design included two within subjects factors of learning type (fact or application) and practice (practice or no practice). The subjects were given multiple-choice practice questions (fact-based and application) and half of the subjects were allowed to practice until the correct answer was given, whereas the remaining subjects were given the correct answer after the second incorrect attempt. Significant results found that students given an orienting activity performed best under reduced time, while students not receiving an orienting activity performed best with longer times. Also, the interaction between processing activity, access time, and practice was significant, with practice having a positive effect on processing activity with 5 seconds access time, but reducing the processing activity differences for the 20-second access time. The researchers believed the interaction between practice and type of learning to be of the greatest consequence, with the effects of practice for factual learning to be the most pronounced. Hannafin, Phillips, and Tripp (1986) concluded that interactive video lesson designs that provide practice yield the greatest benefits for verbal information learning and call for additional research to investigate variations in the design of interactive video.

In another study, Dalton and Hannafin (1987) examined the effects of two interactive video design strategies, knowledge-based versus contextually-based, on recall and application of knowledge. The interactive video lesson taught management of personal finances through the concepts of opportunity costs and the opportunity costs of buying on credit. Selected high school students were randomly assigned to one of three treatment groups, knowledge strategy, context strategy, or control. The knowledge strategy lesson design featured scenes depicting specific factual information, in the form of definitions of lesson concepts. In the context strategy lesson design, subjects were shown scenes that portrayed the utility of the concept, instead of the specific concept definitions. Both strategies included embedded questions and feedback. The control group viewed the interactive videotape in a linear fashion, viewing both knowledge and context segments, but without embedded questions or feedback. The researchers believed the instructional content to be the same, differing only in instructional strategy. Results for the recall measure indicated that both context and knowledge strategies provided comparable support for learning, not significantly different from each other, but greater than the mean of the control group. No interactions were detected for the recall measure. Regarding the application measure, the context strategy group scored significantly greater than the control group and the knowledge strategy group. The control and knowledge strategy groups did not differ significantly and, again, no interactions were found. The context strategy lesson was designed for a higher taxonomy of learning than the knowledge strategy, yet both yielded comparable results. The researchers concluded that context-based design strategies are effective in teaching both levels of learning, application and knowledge.

Jiau (1993) investigated the effects of corrective feedback loops and required mastery of sequential instructional units on learner achievement in teacher education students who completed an interactive videodisc lesson on mastery learning. A convenience sample of students were randomly assigned to a treatment condition with corrective feedback loops and required mastery of each unit, or a treatment condition without corrective feedback loops and required mastery. Both groups completed a posttest after studying the interactive video lesson. The results of the study determined that there were no significant differences between the two treatment conditions. Jiau (1993) proposes repeating the study using non-volunteer subjects.

Simsek and Tsai (1992) examined the effects of homogeneous and heterogeneous ability grouping on achievement and attitudes in elementary school students using a Level-2 interactive videodisc lesson on whales. Students were randomly assigned to a homogeneous group (four similar ability students) or a heterogeneous group (two high ability and two low ability students). Each group cooperatively completed the interactive video science lesson and then completed a posttest and attitude questionnaire. Results indicated that homogeneous low ability groups scored significantly lower on the achievement measure than did the other groups. There was no statistically significant difference in the performance of high ability students in either the homogeneous or heterogeneous groups. Low ability students in heterogeneous groups had significantly better attitude scores than the high ability group members. The researchers conclude that heterogeneous grouping of students is more effective than homogeneous grouping when using cooperative videodisc environments.

Brungardt (1993) investigated student understanding of graphing skills by comparing real-time and delay-time graphing of the motion of objects using an interactive videodisc lesson on kinematics graphing. High school physics students were randomly assigned in groups of two, to either a real-time treatment group or a delay-time treatment group. The real-time graphing instruction produced a kinematics graph simultaneously with the motion of an object. The delay-time graphing instruction produced a kinematics graph after the student had watched the motion of an object. Achievement was measured by posttest assessment, videotaped interview, and videotaped retention interview 3 weeks after the instructional treatment. The study results yielded no significant differences between treatment groups; however, Brungardt (1993) suggests that real-time graphing had advantages over delay-time graphing from evidence exhibited on videotaped interviews. Specifically, real-time subjects had decreased eye movement between computer screen and video screen as graphs were produced and also had more discussion among groups regarding the graphing than did the delay-time subjects.

Doyle (1991) examined whether knowledge of students' learning style could help determine the type of instructional setting (individual or group) most effective for achievement with a Level-3 interactive video physical science lesson.

Middle school students were given a learning style assessment and then viewed an interactive videodisc lesson on energy. Each subject served as his or her own control by receiving the treatment in both the individual setting and the group setting. Posttest assessment was used to measure learner achievement. Doyle (1991) found no significant differences in achievement between viewing the lesson in a group setting as opposed to individual viewing and no significant interaction between learning style and type of instructional setting. The researcher concludes that group presentations of Level-3 interactive video lessons may be as effective as individual viewing of interactive video lessons.

In a health sciences study, Robison (1992/1993) investigated whether problem-based learning could be effective using an interactive videodisc lesson on abnormal blood cells found in acute leukemias. A test group and a control group both viewed videodisc images controlled by the computer. Subjects in the test group were taught to ask systematic questions about the leukemia cells before coming to conclusions, whereas, subjects in the control group were given specific facts about the leukemia cells but not asked to generate any questions. Results of the study indicated that the test group scored significantly better on evaluation than did the control group. Further, the test group using problem-based learning did not require significantly more time to complete the same material. Robison (1992/1993) concluded that problem-based learning produces significantly better achievement than a facts-oriented method when using an interactive videodisc lesson.

Medical Education and Interactive Video

Computerized instructional technology in medical education has rapidly developed since early assessments of CAI in medicine (Harless, Drennan, Marxer, Root, & Miller, 1971; Thies, Harless, Lucas, & Jacobson, 1969). Interactive video was first demonstrated in medical education by Dr. Leo Leveridge (1979) of the American Medical Association (AMA). Then, in 1980, Abrahamson and Wallace introduced interactive mannequin simulators, programmed to exhibit appropriate physiologic signs in response to student-applied therapies. The mannequins were designed to teach residents the skills of endotracheal intubation and induction of anesthesia. The realistic mannequins were "quite life-like in appearance, having a skin-colored, skin-textured plastic covering . . . breathes, has a heart beat, temporal and carotid pulse, blood pressure, opens and closes his mouth, blinks his eyes, responds to four intravenously administered drugs and two gases by mask and bag or by tube" (Abrahamson & Wallace, p. 25). Developed in conjunction with the University of Southern California Medical School, the interactive simulator was found to be an effective teaching aid on which to practice and acquire skills before working with patients.

In 1981, a well-known interactive video simulation was developed by the American Heart Association which combined the mannequin with the computer and the videodisc. In

Cardiopulmonary Resuscitation (Hon, 1982a), the computer is connected to a mannequin with internal sensing devices and to the videodisc player. A video demonstrates proper cardiopulmonary resuscitation (CPR) technique and then the student performs the procedure on the mannequin. The computer, via the sensing devices in the mannequin, assesses the performance of the student and provides feedback via the videodisc. The student may replay segments that require review and may also be tested for CPR certification (Hon, 1982b).

Further advancing integration and acceptance of interactive video in the medical school curriculum, the first interactive patient care simulation videodisc was produced in 1984 (Allan, 1986). In 1988, there were 30 medical schools in the process of developing interactive video curricular materials, the National Library of Medicine had five interactive videodiscs in development and there were two consortia of medical schools involved in producing videodiscs (Culbert, Cantelmo, Stafford, & Allan, 1989). In spite of growing recognition and approval for interactive video in medical education, little research has been conducted to validate its use. There are many more articles in the literature that discuss applications of interactive video than there are research studies. This supports Hannafin's (1985) contention that instructional applications of interactive video are not supported by research. Hannafin (1985) specifically states that the "compelling face validity of interactive video appears to have preempted the developmental research needed to validate empirically the instructional effectiveness of the technology" (p. 235).

In general, articles in the medical education literature describe applications of computer-based learning, and more rarely, report research on a specific application. Research studies reported in the medical education literature usually have little information as to research design, methodology, or statistical analyses, the majority of the studies being descriptive. Jones and Schoultz (1990) conducted a study with interactive videodisc designed to teach basic pathology as a self-study program to medical students. This study, from the University of Arkansas College of Medicine, is part of a larger study involving 70 medical schools in the United States, Canada, the Philippines, and Europe. Second-year medical students were required to study five videodisc modules that took the place of lectures, teaching specific topics that included (a) cellular alterations and adaptations, (b) cell injury, (c) necrosis, (d) edema, hemorrhage, and shock, and (e) thrombosis, embolism, and infarction. A pretest-posttest design for each module and a final examination, generated achievement scores for the students. The overall performance of the medical students increased from a 39% average on the pretest to a posttest average of 83%. An attitude questionnaire found that 90% of the students believed the interactive modules increased their knowledge of basic pathology in these areas. The researchers conclude that using interactive video was a successful alternative to traditional lectures in basic pathology. It is interesting to note that Jones and Schoultz (1990) state that with the next interactive video research project they would be "less concerned with controlling the experimental conditions" (p. 10) and instead focus on the quality of the modules.

Jensh (1987) evaluated an interactive videodisc produced by Jefferson Medical College of Thomas Jefferson University, which taught volunteer medical students the histology of the respiratory and integumentary systems. After completing the interactive video lesson, students evaluated the lesson with written and oral comments. The students were found to be strongly in favor of interactive video to teach histology. .

In an interactive videodisc lesson designed to teach use of peripheral blood smears in evaluating anemia to third-year medical students at Columbia University, Garrett, Savage, and Hendrickson (1989) compared pretest and posttest scores and obtained a Likert scale attitude score. Results indicated that mean scores increased from 66% to 87%, which the researchers found to be statistically significant. Results from the attitude questionnaire were positive for the interactive video lesson.

A cardiology patient simulator named HARVEY combined with an interactive videodisc program was developed by seven medical schools to provide instruction in clinical cardiology assessment and problems (Wooliscroft, Calhoun, Haken, &

Judge, 1987). The cardiology simulator may be used by the medical student to learn and practice physical assessment and to study pathophysiology and treatment modalities through case history problems. HARVEY has carotid and femoral pulses, breathes, has a blood pressure, precordial movements, heart sounds, and heart murmurs. Using the interactive videodisc, the medical student can work through clinical problems, receiving feedback at each step. The student may order lab studies, x-rays, or echocardiograms and receive the results immediately through the random access feature of the interactive videodisc. The teaching effectiveness of HARVEY was investigated at several medical schools. Sajid, Ewy, Felner, Gessner, Gordon, Mayer, Shub, and Waugh (1990) compared medical students assigned to the simulator to students assigned only to patients at the University of Miami School of Medicine. The researchers found that the students who used HARVEY performed significantly better on cognitive and clinical skills than did the patient only group. Further, it was determined that the skills learned with the simulator were transferable to patients. In a similar study at the University of Michigan School of Medicine, Wooliscroft, Calhoun, Haken, and Judge (1987) determined that second-year medical students exposed to HARVEY performed significantly better on assessment and interpretation of carotid pulses and precordial auscultation than did students exposed to patients only. Researchers at both institutions concluded that use of the interactive video patient simulator supported student skill acquisition.

Boston University School of Medicine (Culbert, Cantelmo, Stafford, & Allan, 1989) examined the effectiveness of an interactive videodisc lesson on the evaluation and management of a multiple trauma victim in a motor vehicle accident. One group of medical students viewed the interactive videodisc lesson and a second group of students received traditional instruction in trauma management. Both groups were given a pretest and posttest to determine decision-making and problem-solving skills. Results indicated that the videodisc group received significantly better scores than did the traditional instruction group, especially for those students who scored greater than 60% on the pretest. The researchers concluded that interactive video is a significant addition to the curriculum.

An elaborate use of interactive video in medical education has been the development of a voice-activated clinical case simulation by Dr. William Harless at the Lister Hill National Center for Biomedical Communications (Harless, 1986). Use of the interactive videodisc allows dramatization of predetermined situations through random access to a variety of visual and aural materials. Voice recognition allows natural language interaction with the characters in the drama. The computer supports an intelligent interface between the user and the system, allowing for probability-based decision-making and evaluation of student performance.

Five patient simulations have been developed. First is a case history of a man with upper gastrointestinal bleeding who is an alcoholic and a smoker. The second interactive simulation concerns a woman who is morbidly obese with many personal problems. The third case concerns a geriatrics patient; the fourth, a patient with end-stage emphysema, and the fifth case is about a patient who suffers a myocardial infarction. The user of the system, usually the professor, plays the role of physician and in concert with the students, interviews and examines the patient. The voice recognition system is trained to the voice of the user, which takes about 30 minutes to accomplish. After the patient's history is taken, a plan is formulated for diagnostic workup and management. The students may select any number of possible paths for care of the patient and view the patient's progress. The students may even ask the patient what he or she is thinking at any point in the process. Responsibility for managing the patient remains in the hands of the professor and the students. If the patient is hospitalized, probabilities for crises are built into the system. If the patient survives the treatment and management by the students, then discharge plans must be formed. The interactive case study gives the students feedback at the end point of the drama when the outcome has been determined.

The five interactive simulations were field-tested at Georgetown University School of Medicine, University of Miami School of Medicine, University of Cincinnati School of

Medicine, and Albany Medical College (Harless, Duncan, Zier, Ayers, Berman, & Pohl, 1990). The principal finding was that, in a group setting, a large majority of students became individually committed to the care and management of the simulated patient, feeling as if they had interacted with an actual patient. The researchers conducting the field-tests concluded that the interactive videodisc patient simulation drama was validated, providing an effective method to teach patient-centered problem management.

Interactive video appears to have a unique capacity to enhance faculty and student performance by providing rapid access to a large data base of visual and aural materials and to provide realistic patient care simulations. However, the need for scientific research to validate claims of effectiveness, the impact on the cognitive structure of the medical student, and the type of medical student most suited to this method of instruction, is critical.

Cognitive Style

Cognitive psychology is concerned with how learners gain knowledge about their world and how they use that knowledge to guide decisions and perform effective actions. Bower and Hilgard (1981) describe the cognitive system as an instrument of adjustment that aids the learner in guiding purposeful action. Through the cognitive system, the learner acquires information about the environment and forms plans based on this information that allow adaptation and success within the learning environment.

Coop and Siegel (1971) found that the research on cognitive styles reflects the tremendous variability in the ways individuals process information and hence in the manner in which they approach learning. Sperry (1972) suggests that cognitive style differences are based upon variations of cognitive structure, with learning style being an outgrowth of how the learner thinks, solves problems, and perceives stimuli. This personal method or style of learning, is a key element in the educational process.

Cognitive Style Theory

Cognitive styles research has a history of more than 30 years, generally studied in many subfields of psychology. However, in recent years, researchers have investigated many issues relevant to education. A theoretical framework developed from the larger theory of psychological differentiation (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962) is field dependence-independence, conceptualized by Witkin, Moore, Goodenough, and Cox (1977).

Subsequent research on the concepts of field dependence-independence was further supported in many studies using both perceptual and problem-solving tasks (Witkin & Goodenough, 1981). The broadened scope of individual differences was viewed as another conceptual step in field dependence-independence theory. The enlarged dimension of individual differences was then conceived as "an articulated field approach" at one end of the continuum and a "global field approach" at the other end. The person who experiences an articulated approach can perceive items as discrete from a background when the field is organized or impose structure when the field has little inherent structure. Thus, the ability to analyze experience and the ability to structure experience are aspects of increasing articulation. With the global field approach, when the field is structured, there is a tendency for the organization itself to dictate the manner in which the field is experienced; if the field is not structured, experience tends to be diffuse (Witkin, Oltman, Raskin, & Karp, 1971).

A large body of research since development of the larger differentiation theory (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962) and the conceptualization of the articulated versus global field approach (Witkin, Moore, Goodenough, & Cox, 1977) has been concerned with cognitive functioning in perceptual and intellectual activities. Witkin (1964) began to use the concept of cognitive style, as it applied specifically to the articulated global field approach dimension. Research had shown the dimension to be pervasive, involved with the perceptual, intellectual, personality, and social domains, as well as stable over time (Witkin & Goodenough, 1981). However, this dimension was soon lost in the literature because of the wide application of the field dependence-independence label. Soon, it became common practice to refer to cognitive style as being field-dependent or field-independent.

Consistent gender differences have been found in the field dependence-independence dimension, first reported by Witkin, Lewis, Hertzman, Machover, Meisner, and Wapner in 1954. When Witkin et al. (1962) further examined the groups from the body orientation tests, he found that men, as a group, tended to be field-independent, while women tended to be field-dependent. This finding led to the speculation that men and women might differ in their cognitive styles. Subsequent studies (Coates, 1974; Coates, Lord, & Jakabovics, 1975; Doyle, 1975; Maccoby & Jacklin, 1974; Newcombe, Bandura, & Taylor, 1983; Sherman, 1967; Tegano & Faulkender, 1983) report the persistent finding that field-independent individuals, who are most often male, outperform field-dependent individuals, who are most often female, in a wide range of tests of spatial and analytical abilities. However, an interesting finding across several studies (Chynn, Demick, Garrod, & DeVos, 1991; Coates, 1974; Linn & Peterson, 1985; Maccoby & Jacklin, 1974) is that preschool girls are more field-independent than boys. This finding has led investigators to attempt to determine what factors are responsible for gender differences in field dependence-independence and what factors are responsible for the usual change in cognitive style as boys and girls mature. Chynn, Demick, Garrod, and DeVos (1991) found that sex-role stereotyping, same-sex typing for boys (males who prefer male children's activities) and cross-sex typing for girls (females who prefer male children's activities), was a significant predictor of field-independence. Also, the researchers determined through regression analyses, that by 5.3 years of age, the boys, as a group, began to surpass the girls on measures of field-independence. Witkin, Oltman, Raskin, and Karp (1971) also report consistent gender differences on measurement of the field dependence-independence dimension when using the Embedded Figures Test and other tests of cognitive style, and recognize that gender differences may switch after the preschool years and again in the geriatric years.

Based on 30 years of field dependence-independence research, Witkin, Moore, Goodenough, and Cox (1977) believed their cognitive style approach could be applied to issues important in education. Wapner and Demick (1991) agree that there is a sufficient body of empirical research to suggest that field dependence-independence has educational implications for how students learn, how information is processed, how instruction is designed, and how teachers interact with students.

Cognitive Style Research

After reviewing a large body of research concerned with field dependence-independence theory and learning, Witkin, Moore, Goodenough, and Cox (1977) concluded that the major learning characteristics of field-dependent and field-independent learners were related to the theoretical differences that surmised their cognitive style. Strengths of the field-dependent learner were derived from their superior social skills, whereas the strengths of the field-independent learner were derived from their superior cognitive restructuring skills. For example, the field-independent person, because of his or her ability to analyze and restructure, would find working on a jigsaw puzzle more enjoyable than would a field-dependent person. Furthermore, the field-dependent person, because of his or her propensity to deal with the environment in a holistic manner, would enjoy social interaction more than the field-independent person. Based on the Witkin, Moore, Goodenough, and Cox (1977) review, characteristics of the field-independent learner included (a) ability to make greater use of analyzing and structuring processes, (b) adoption of an active, hypothesis-testing role in learning, (c) being less dominated or controlled by the most obvious or salient cues in learning, and (d) operating from internally defined goals, and thus more likely to be driven by intrinsic or task-oriented forms of motivation. In contrast, the field-dependent learner was characterized as (a) making less effective use of analyzing and structuring processes, (b) adopting a passive, spectator role in learning, (c) being more dominated by obvious cues in learning, (d) operating from externally defined goals and more influenced by extrinsic forms of motivation, and (e) better at learning and remembering information having social relevance or content.

This major review of cognitive style was followed by much research determined to study how field dependence-independence interacted with the cognitive processing. Davis and Frank (1979) reported that field-dependent learners were less efficient in processing feedback information, leading to less learning achievement. Also presented in this study was evidence that field-dependent learners had less efficient short-term memory processes. Davis and Frank (1979) conclude that differences between field-independent and field-dependent learners were not due to utilizing different processes but related to less efficient information processing by the field-dependent learners. Subsequent research by Hennessey and Nahinsky (1980) and Reardon, Jolly, McKinney, and Forducy (1982) has produced results consistent with Davis and Frank (1979).

Davis (1991) reviewed several studies related to information processing and field dependence-independence and found evidence linking field-dependence and information processing differences in attention and encoding in both short-term and long-term memory. Specifically, field-dependent learners were found to have difficulty attending to relevant cues in instruction, especially if distracting cues were present, and were found to prefer a slower pace of presentation. Also, few significant differences existed between field-dependent and field-independent learners when a limited amount of information was processed; however, when larger amounts of information had to be processed, field-independent learners were more accurate and efficient. With regard to long-term memory, recall of information was generally better with field-independent learners. Several of these researchers (Adejumo, 1983; Avolio, Alexander, Barrett, & Sterns, 1981; Berger & Goldberger, 1979; Collins-Eiland, Dansereau, Brooks, & Holley, 1986; Frank, 1983; Spiro & Tirre, 1980; Strawitz, 1984) suggest that superior performance by field-independent learners was related to better cognitive organizing and structuring skills. These studies support the cognitive restructuring component of field dependence-independence theory.

With regard to field dependence-independence and academic achievement, Witkin et al. in their 1977 review, state that the relationship depended on the grade level. At the elementary level, a definite relationship between field dependence and achievement was found. At the high school and college levels, Witkin, Moore, Goodenough, and Cox (1977) indicate that a weak or nonsignificant relationship existed between cognitive style and overall grade point average. They reported correlations from their longitudinal study of .05 for women, and .08 for men. Other researchers (Caliste, 1985; McDonald, 1984; Savage, 1983; Thomas, 1986), however, report significant correlations between field-dependence and grade point average ranging from .15 to .48, inconsistent with the trend reported by Witkin et al. (1977).

Witkin et al. (1977) in their review on cognitive styles, suggest that educators attempt to adapt instructional treatments for individual learning needs. Cronbach and Snow (1979) developed a strategy known as aptitude treatment interaction (ATI), that involved designing instructional treatments to compliment the learning characteristics of both field-dependent and field-independent learners. Results for ATI studies have been mixed. Canino and Cicchelli (1988) report no differences for cognitive style, instructional treatments, or the interaction of both in a mathematics computer-assisted lesson. Carrier, Davidson, Higson, and Williams (1984) report that field-independent students outperformed field-dependent students in a computer-assisted lesson on advertising concepts, regardless of instructional treatment. Conversely, Douglass and Kahle (1978) have found a significant interaction between field-dependence and instructional sequencing on achievement in a high school biology lesson. Smith (1985) reports higher achievement for field-independent students in a computer-assisted grammar lesson on comma usage and suggested that CAI may not be the preferred instructional method for field-dependent learners.

In summarizing cognitive styles research, a noticeable trend emerges that finds field-independent students better learners and achievers than field-dependent students, consistent with the observations of Witkin et al. (1977). Little evidence exists in the research that indicates an advantage for field-dependent students. Davis (1991) points out the need for additional research to examine methods of adapting instruction to an individual's cognitive style.

Cognitive Style and Interactive Video

There have been few research studies which have examined cognitive style variables and the impact of field dependence-independence on learning with interactive video. As interactive video is a relatively new technology, much of the initial research focused on effectiveness in the learning environment. Subsequent research examined instructional strategies and methods of adapting interactive video lessons to individual learners. The interaction of cognitive style with instructional strategies and with performance has recently been questioned in an effort to provide students with optimal instruction.

Burwell (1991) examined the interaction of field-dependent and field-independent learners with two instructional strategy groups and an experimental control group, using an interactive video lesson on astronomy. Cognitive styles of college students were measured and determined to be field-dependent or field-independent. Subjects were randomly assigned to a program control group (limited choices of pace, sequence, and examples), student control (maximum choices of pace, sequence, and examples), and experimental control (self-study guide with no interactive component). Results indicated that learning achievement with interactive video was superior to use of the self-study guide. There was a significant interaction of cognitive styles with the program and student control groups. For the field-dependent subject, student control produced greater achievement, and for the field-independent student, program control was the best instructional method. These results are the reverse of those hypothesized by the researcher and opposite of the relationships predicted by field dependence-independence theory.

In a similar study, Hytner (1987/1988) investigated the effect of cognitive style and degree of learner control on performance and attitudes of college students learning basics of photography using an interactive video lesson. Cognitive style was measured by the Group Embedded Figures Test and subjects were determined to be field-dependent or field-independent. After subjects were randomly assigned to one of three treatment levels, learner control, guided control, and program control, and completed the lesson, six dependent variables were observed. Five of these were performance variables, including achievement, time-on-task, selection of options, requests for assistance, and retention. The remaining dependent variable was attitude. Results indicate that significant differences for time-on-task and selection of options variables due to instructional treatment, whereas cognitive style was responsible for significant differences in requests for assistance and time-on-task variables. Both instructional treatment and cognitive style produced significant differences for the attitude measure.

Pollack (1987) studied the interaction effects of cognitive style, field-dependent and field-independent, and structural organizer conditions, including study organizer, mastery criterion organizer, and no organizer control, while using an interactive video lesson on anatomy and physiology of the heart. Results indicate that field-independent subjects' performance on posttest achievement measures was significantly higher than field-dependent subjects. Interaction effects were not confirmed; however, cell means were consistent with field dependence-independence theory, suggesting that mastery of an advance structural organizer facilitates information acquisition and retrieval for field-dependent learners.

Investigation of the effects of question location and cognitive style on retention and student perceptions of instruction was conducted by Wang (1989). The Group Embedded Figures Test was used to determine cognitive style, field-dependent or field-independent. Subjects were randomly assigned to one of two treatments, questions-at-end or questions-interspersed, and studied an interactive videodisc biology lesson. There was a significant main effect of cognitive style on retention, with field-independent subjects demonstrating higher achievement than field-dependent subjects. The researcher concludes that cognitive style was the only factor that affected retention of the interactive video biology lesson.

Mason (1992) studied the effects on achievement and attitude of field-independent and field-dependent college chemistry students using an interactive videodisc course on simulated chemistry laboratory experiments. Subjects participated in one of two treatment conditions, either an unstructured program with no section questions or a structured program with section questions. The results indicated that field-independent learners had significantly greater achievement than did field-dependent learners; however, there were no differences between instructional treatments in attitude or achievement.

Locus of Control

The computer as an instructional delivery system allows the instructional designer a multitude of options. Instruction utilizing the computer can be designed with many different presentation formats such as drill and practice, tutorial, or simulation. The computer also offers various options for interaction, feedback, and management (Hannafin, 1984). Through instructional design, computers provide a highly controlled environment where manipulation of instructional variables is accomplished. Consequently, the computer has been praised as a powerful instructional tool.

One of the most important features of the computer is the almost unlimited range of instructional control options available to instructional designers of software and interactive videodiscs used in education (Burke, 1982). Tennyson and Rothen (1979) state that the type of control "depends on the purposes of the educational process, the educational philosophy of the administrative structure, and the student's own learning abilities" (p. 63). With regard to individual differences and student abilities, Carrier, Davidson, and Williams (1985) believe that no technology provides more opportunities to respond to individual learner needs than the computer. Educational researchers state the need for further research to determine which types of students will benefit from control options and research to determine how much control is beneficial to the learner (Carrier, 1984; Snow, 1980). This information directly benefits the instructional designer with knowledge of how and when to use the powerful capability of control in designing courseware for instructional technology (Hannafin, 1984).

Locus of Control Theory

Beliefs about control impact behavior and education in significant ways. One of the most powerful is the expectancy for internal versus external locus of control of reinforcement, often referred to as locus of control. This variable has been studied extensively in many diverse fields, from psychology to political science to health care. Rotter (1954) integrated reinforcement theory and cognitive or field theories, resulting in social learning theory which organized both theoretical and clinical concerns. Internal-external expectancies are embedded within Rotter's social learning theory. Rotter's theory infers that behavior is a function of expectancy and reinforcement value in a specific situation, reflecting the consistent individual differences among persons (Strickland, 1989). The basic assumption in social learning theory (Rotter, 1954) is that there is an interaction between an individual and his or her meaningful environment. Rotter (1954) has theorized that not only did learning take place differently in chance versus skill situations, but took place differently among individuals in situations that might be considered ambiguous or had elements of both chance and skill.

Internal control refers to the degree to which persons expect that a reinforcement or outcome of their behavior is contingent on their own behavior. External control is the degree to which persons expect that the reinforcement or outcome is a function of chance, fate, luck, is under the control of others, or is simply unpredictable (Rotter, 1966). Such expectations about behavior are considered to be a product of one's history of reinforcement.

Internally controlled individuals have been found to seek more information when faced with choices, whereas externals rely on the advice of others (Davis & Phares, 1967; Pines, 1973). Internals as compared to externals have also been found to deliberate more intensely when a decision has serious consequences (Wheeler & Davis, 1979), to be more confident in their own judgments, and to require more time to make difficult decisions (Lefcourt, 1972). For those individuals who expect personal control, a lack of control becomes more distressing and influences the degree of anxiety that the individual experiences (Folkman, 1984). Internals have many of the attributes related to creativity, such as autonomy, seeking information that may lead to significant change, willingness to take reasonable risks, selfconfidence, and a positive self-image (Barron & Harrington, 1981).

With regard to education, Rotter (1966) pointed out that there are considerable individual differences in the perception of control which must be taken into account in any application. Learning theorists have suggested that students may benefit from having control over instruction. Carroll (1963) has theorized that students differ in the amount of time required to learn a given task and that they should be given ample opportunity to accomplish the task. Bloom (1976) has suggested that students learn at different paces and learner control over pacing of instruction would help students master objectives. Instructional design theorists have also advocated learner control. Merrill's (1983) Component Display Theory dictates that learners have control over content, pace, instructional strategy or cognitive strategy. Reigeluth and Stein (1983) contend in their elaboration theory of instruction that instructional effectiveness, efficiency, and affective appeal of instruction would increase under learner control conditions. Rogers (1969) theorizes that students should have choices in the classroom and the opportunity to select experiences and learning materials, which is the premise of his motivation theory of instruction.

The computer is a powerful medium for designing learner controlled instruction to meet individual needs. Although theorists have indicated that learners should be given control over instruction, researchers continue to attempt to establish the benefits of control, who should be given control, and what types of control are beneficial. Locus of instructional control strategies range on a continuum from completely learner controlled to program controlled, where the learner has no control options. Klein and Keller (1983) suggest that researchers continue to study learner controlled questions, investigating the impact of individual differences. Williams (1993) notes that most of the research on learner control has been conducted with computer-assisted instruction, and very little done with interactive media. Strickland (1989) believes that our willingness to build on our theoretical knowledge of locus of control will bring great strides to our understanding of human behavior and learning, and the complex integration of cognition, affect, and action, and ultimately, have an effect on the potential of the learner.

Locus of Instructional Control Strategies

The computer is a dynamic medium, capable of instantly varying the learning environment through features such as content selected, modalities featured (for example sound, animation, or graphics), sequencing of topics, amount and difficulty level of practice, and type of feedback. These properties of the lesson can be individualized as learner needs dictate. Compared to traditional lectures, computerized learning can be adapted to each individual rather than the normative characteristics of an entire class of students (Ross, 1984). Compared to programmed instruction, the computer can make adaptations during the course of a lesson as learner needs change (Rothen & Tennyson, 1978).

The means of instructional control in learning is defined by Hannafin (1984) as a "continuum ranging from fully externally controlled to completely internally controlled" (p. 6). Hannafin (1984) further defines external locus of instructional control as instruction in which all learners follow a predetermined sequence established by the designer. The learner is not given any opportunity to exercise individual judgment. Internal locus of instructional control is found in lessons where the individual controls the path, pace, and methods of the instruction by specifying choices from a wide range of options embedded by the designer (Hannafin, 1984). Many researchers refer to these locus of instructional control options as program control, which is the external locus and the most dictatorial, and learner control, which is the internal locus and the most liberal form of instructional control.

Program control makes decisions for learners executed under a fixed lesson design. The program determines choice of options and movement through the lesson, preselected by the designer. Program control was developed initially as an attempt to solve the problem of adjusting instruction to individual students. Skinner (1958) developed his teaching machine to allow students to progress at their own rates;

however, since all students received the same instructional order, the programmed lesson was not individualized (Cohen, 1963). Crowder (1959) developed procedures to program instruction with provisions for branching able students through the lesson, while providing less able students with remedial frames when needed. Many of the early program control methods relied primarily upon intuition of the learning process rather than theories of learning or instruction (Tennyson & Rothen, 1979). With the influx of educational technology systems, several researchers have developed successful program controlled strategies (Park & Tennyson, 1983; Ross & Rakow, 1981; Tennyson & Rothen, 1979). These strategies have proved effective for teaching a variety of skills and for reducing instructional time (Edwards, Norton, Taylor, Weiss, & Dusseldorp, 1978; Kulik, Kulik, & Cohen, 1980), most notably in mathematics education. However, one of the major criticisms of program control designs is the assumption that the designer is the best judge of how much instruction is needed to learn a skill, as well as the path to accomplish the task (Hannafin, 1984). Because the learner cannot control the sequence or the number of examples or practice items, more able learners may be required to complete instructional segments that are unnecessary given their individual learning styles.

Learner control assumes that the student is responsible for the learning strategy. This orientation allows learners to make decisions about what they want to learn by selecting options presented at various points during the lesson. Computer technology has facilitated the use of learner control as an interactive system that makes it possible for students to decide, on-task, the amount and method of instruction. A wide range of learner controlled strategies has been developed (Bunderson, 1974; Caffarella, Cavert, Legum, Shtogren, & Wager, 1980). Because of the popularity of learner controlled designs, this method of lesson management has become the standard by which other computer-based instructional designs are judged (Tennyson & Rothen, 1979). This strategy has an extensive supporting basis of research (Alpert & Bitzer, 1970; Kaplan & Rothkopf, 1974; Tennyson, Steve, & Boutwell, 1975).

Locus of control with regard to instruction has been the topic of extensive study, particularly with computer technology (Milheim & Azbell, 1988; Steinberg, 1977; Tennyson, 1980). As there have been inconsistencies in the research findings, Snow (1980) suggests further research to better understand the conditions of effective learner control. Hannafin (1984) cautions that the amount and type of control is significantly affected by the learning task and the learner characteristics; therefore, learner control research should strive to fully explore these variables.

Learner Control Research

Accommodating individual differences in learners remains a concern for all educators. One method of attempting to address individual differences has been through instructional technology systems designed to give the learner control of the instruction. Skinner (1958) conducted early research on programmed instruction and reported achievement gains with immediate feedback and improved attitudes through self-paced learning. Carroll (1963) studied the value of self-paced instruction, which became the basis of the successful mastery learning system (Block, 1971). Keller's (1974) Personalized System of Instruction, and the Individually Prescribed Instruction System developed by Glaser (1968) are both theoretically based on learner control. Early research with computer-assisted instruction adhered to the principles of self-pacing and learner control (Atkinson, 1968). As educational technology systems have become more sophisticated through computers, instructional designers have generally accepted learner control of instruction as a method of adjusting for individual learning differences. However, educational researchers caution that instructional locus of control is a recurring but as yet unresolved issue (Belland, Taylor, Canelos, Dwyer, & Baker, 1985; Snow, 1980; Tennyson & Buttery, 1980).

Learner control of sequencing

Several researchers have addressed the issue of learner control of sequencing when utilizing computer-assisted instruction (CAI). Fisher, Blackwell, Garcia, and Greene (1975) studied the effect of student control of sequencing in a CAI mathematics lesson, randomly assigning subjects to a choice of sequencing of math problems or a yoked control condition, which allowed no choices. The dependent variable was task engagement, with choice of sequencing subjects showing significantly more task engagement.

Gray (1987) studied the effects of two types of CAI sequencing, linear, during which the student could control for sequencing only during review, and flip, which allowed the student to make decisions of sequencing during each step of the lesson. Gray (1987) determined that students in the flip sequence condition performed better on a comprehension measure but not on a retention measure, concluding that too much sequence control may distract the learner.

In contrast, Newkirk (1973) has reported no significant differences on posttest achievement, but significant differences in retention between two versions of a CAI lesson to teach a hypothetical computer language. The learner control group, which allowed complete freedom of sequencing, scored much higher 2 weeks after the lesson than did the fixed linear group, where learners had no sequencing freedom.

Tennyson, Steve, and Boutwell (1975) studied CAI sequencing and the effect on concept acquisition in two groups, students with complete control of sequencing and students following a prescribed course. The students who were given control of sequencing, completed instruction sooner, and were better able to implement learned behaviors, than did the students in the prescribed course group.

Campanizzi (1978) also reported positive achievement gains for learner controlled CAI sequencing when compared to program control of sequencing, determining that increased control led to greater performance on posttest measures. Tennyson and Buttery (1979) have determined that students who are given complete control of instructional sequencing, develop successful strategies that are significantly different from those established by instructors. Tennyson (1972) concludes, in a review of the experimental methodology used in instructional task sequencing research, that the learner is capable of sequencing instruction when the objective or goal of the instruction is understood.

Learner control of pacing

Fernald, Chiseri, Lawson, Scroggs, and Riddell (1975) studied the effects of pacing in a Personalized System of Instruction (PSI) course. Students were assigned to teacher-paced or student-paced groups. The teacher-paced students were required to take quizzes for assigned units on specified dates according to a course calendar. Student-paced subjects were allowed to take quizzes as rapidly or as slowly as they wished. At the end of the course, the student-paced individuals scored significantly higher on posttest achievement measures and also indicated strong preferences for student-pacing.

Using a CAI lesson designed to teach subjects the anatomy and physiology of the heart, Belland, Taylor, Canelos, Dwyer, and Baker (1985) assigned students to three types of pacing. The levels of pacing included self-paced, external-paced plus normal reading time plus cognitive processing time, and external-paced plus normal reading time, no cognitive processing time. Learning was evaluated using five achievement tests ranging in difficulty from memorizing facts to problem-solving. Results indicate that moderate levels of external pacing produced higher learning achievement with the self-paced group scoring the lowest.

Few studies have examined whether various pacing procedures might be differentially effective for various types of students. Reiser (1980) investigated the interaction effects of three pacing procedures and perception of locus of control (internally or externally controlled) on final exam performance. The pacing options used in the study were reward, adding points to test scores if unit tests were mastered on or before deadlines, penalty, subtracting points if unit tests were not mastered on or before deadlines, and control, which involved informing students of suggested deadlines, but contained no reward or penalty condition. Results indicated that effects of pacing procedures on achievement varied according to locus of control. Internal students performed better under a penalty pacing procedure, whereas external students performed almost equally well under a reward or neutral procedure. The researcher postulates that anxiety, especially in the penalty condition, could have affected performance. Unfortunately, anxiety was not measured in this study.

Learner control, achievement, and instructional time-on-task

Goetzfried and Hannafin (1985), using a CAI lesson, studied the effects of three locus of control strategies on the accuracy and efficiency of learning mathematics rules and applying the rules to problems. The three treatments were adaptive control, consisting of program controlled instruction with branching for students requiring review, learner control with advisement, consisting of individually controlled instruction with advice for review, but not required to be followed by the learner, and linear control, an externally controlled lesson without advisement or control over review. Results indicate that the adaptive control and the learner control with advisement strategies required greater instructional time, with no associated gain in achievement. The linear control strategy yielded comparable achievement with significantly less instructional time.

Using similar locus of instructional control strategies, Coorough (1990) examined the effects of learner control, learner control with advisement, and program control on achievement and instructional time in a CAI lesson on the effects of alcohol in the body. Findings indicate that there were no significant differences on learner achievement between lesson control strategies and that learner control with advisement required a significantly greater amount of time to complete.

Tennyson (1981), in a CAI lesson on physics concepts, determined that students required less instructional time in a learner controlled with advisement strategy and performed significantly higher on a posttest than did students in a program controlled with advisement strategy. Tennyson (1981) contends that a learner controlled condition is especially valuable for instructional management in computer-assisted instruction, if students receive continuous information about their progress toward mastery of the learning objective.

In an investigation of an experimental learning task requiring minimal prerequisite knowledge and simple content structure (use of only one or two concepts), Tennyson and Rothen (1979) have determined that the learner control strategy resulted in less time-on-task than did the program control strategy. However, achievement was equivalent for both lesson control strategies.

Ross and Rakow (1981) studied the effects of a self-paced lesson on math rules in which the number of supporting examples had been adapted to pretest scores through program control, selected through learner control, or kept constant. On achievement measures, the program control group scored consistently higher than the other groups, with learner control subjects scoring the lowest. Ross and Rakow (1981) conclude that when comparing learner control to program control, the most important question to consider is "for whom and under what conditions each approach functions most effectively" (p. 752).

Merrill (1980) also stresses that the challenge is not whether to use learner control but rather how to help each student best use the learner control that is available. Snow (1980) contends that learner control has generally failed to produce consistently positive effects due to our lack of knowledge about the types of learners who should be granted control. Snow (1980) further states that if research demonstrated that certain abilities and cognitive characteristics led to higher achievement under learner control, then instruction could be designed giving students with those characteristics decision-making power.

Locus of Control and Cognitive Style

Based upon a large volume of research, educators have concluded that the ability of the learner to acquire and process different types of information is mediated by a wide variety of individual differences. Cronbach and Snow (1979) have also concluded that an individual's ability to perform certain skills and acquire certain information may be mediated by the instructional treatment. The implication is that we can accommodate individual differences, such as cognitive style, by altering the interaction the learner has with the instruction. Jonassen (1985) believes the nature of the instructional treatment, for example learner control, to be the most productive learner characteristic on which to adapt instruction. Furthermore, Jonassen (1985) states that the instructional treatment should be adapted on the basis of the cognitive style of the learner.

Witkin's (1961) model of information processing, characterized by the field-dependence to field-independence continuum, has been studied to determine relationships with locus of control strategies. Carrier, Davidson, Higson, and Williams (1984) studied learners classified as field-independent or field-dependent as determined by the Group Embedded Figures Test (GEFT) and their response to learner control in a CAI lesson on advertising concepts. Learners were randomly assigned to one of two treatments, options or no options. The subjects in the options treatment were given the choice to see four options, additional definitions, additional expository instances, additional practice examples, and analytical feedback. The no options subjects were not given the choice to see any options. The subjects were tested for achievement and retention. Mean scores were highest for the field-independent-options group and lowest for the field-dependent-no options group. There were no significant differences for instructional treatment. Within the options groups, the field-dependent subjects chose significantly more examples than the field-independent subjects, and it was also determined that as the options subjects moved through the lesson, frequency of selection of options declined. The researchers conclude that field-dependent learners would benefit from more instruction and that further research should examine frequency of options and how types of options relate to learner characteristics.

Fry (1972) examined the cognitive characteristics of inquisitiveness and aptitude and the effect on student control of instruction. Inquisitiveness was determined by a battery of six tests given to a group of undergraduate college students. Aptitude was derived from standardized scores on college aptitude tests. Students were randomly assigned to view a videotape lesson about how to use a computer with one of three instructional treatments, including student control, instructor control, or random treatment. Student control allowed the subject to decide the sequence and the pace of each videotape segment and ask questions of the experimenter. All questions and answers were recorded on videotape for use with the other treatment groups. Instructor control subjects viewed the videotape in a fixed sequence determined by expert reviewers and were not allowed to ask questions, but could review the previously recorded questions and answers. In the random treatment group, the subjects viewed the videotape in a completely random sequence and were also allowed to view the recorded questions and answers. A control group received no instruction or information about computers. Performance was measured by pretest-posttest design. Results showed that high aptitude-high inquisitive subjects learned significantly more under a student control condition. High aptitude-low inquisitive subjects demonstrated greatest achievement under the instructor control condition. Results for low aptitude subjects were inconclusive, with low aptitude-high inquisitive subjects learning the least in the student control condition, contrary to expectations. Low aptitude-low inquisitive subjects performed poorly in all conditions.

Overall, subjects learning under instructor and random control treatments achieved more than the subjects in the student control group, with the exception of the high aptitude-high inquisitive group. The researchers conclude that individual differences are related to locus of control strategies of instruction, thus, if a student were high in both aptitude and inquisitiveness, he or she should be assigned to a learner control situation, and otherwise, be assigned to an instructor control environment.

Marx, Howard, and Winne (1987) examined the relationships between field dependence-independence and locus of control with students' perceptions of instructional cues, cognitive responses to instructional cues, and achievement. Using a videotaped lesson on how to get along better with people, it was determined that neither cognitive style nor locus of control were related to instructional cues and cognitive responses; however, they were related to achievement. The researchers suggest that instructional cues and intended cognitive responses can serve as a link to assist the student in the learning environment. Further, they note that studies are needed to investigate ways in which teachers can make more explicit their intentions for students' cognitive processing and for students to be taught cognitive strategies for learning at appropriate times during instruction.

Locus of Control and Interactive Video

Specific studies investigating use of learner control and interactive video, without comparison to traditional instruction or another medium, have been few in number. However, there are studies of importance in this area. One of the first investigations of learner control and interactive video was conducted by Laurillard (1984). With interactive videotape, this study showed that students make sequencing choices often different from expected choices. Also, Laurillard (1984) determined that students prefer advice on what sequence or strategy to use at a certain point and make use of this advice when offered. The researcher concludes that student control of sequence is vital because the student's choice is likely to be more meaningful than a predetermined route chosen by the instructional designer.

Gay (1986) investigated the effects of learner control on achievement and time-on-task in an interactive videodisc (IVD) lesson on protein synthesis. College biology students were administered a pretest to measure understanding of the process of protein synthesis and were randomly selected based on high and low scores to participate in the study. Scholastic Aptitude Test (SAT) scores revealed no significant differences between the groups. Subjects were randomly assigned to a program or learner control treatment. Program control subjects had to complete the learning task in a specified order, which was logically sequenced by the instructional designer. The program control format consisted of presenting the rule regarding protein synthesis, examples, and practice. Learner control subjects controlled the pace, sequence, presentation mode (video, audio, graphics, or text), amount of practice, number of examples, and need for review or remediation. Results indicated that low-pretest subjects in the learner control treatment performed the poorest on the posttest, significantly different from the other three groups. Further, there was a significant interaction between pretest scores and time-on-task, with high-pretest subjects in the learner control condition significantly more efficient than all other groups in use of time. Gay (1986) suggests that there is an interaction between learner control of instruction and prior familiarity with the content to be learned. Learners with high pretest scores (prior understanding of the content) were able to function well in both treatments, whereas learners with low pretest scores did poorly with control of the lesson. The researcher further suggests that prior understanding may have served as an advance organizer, providing the necessary anchors to allow new material to be incorporated into the learner's cognitive structure. The presentation of well-structured materials becomes considerably less important when the learner is familiar with the content, consistent with Ausubel's theory of meaningful learning.

Ho, Savenye, and Haas (1986) examined the effects of orienting objectives and review options on three types of learning in an interactive videodisc lesson designed to teach proper methods for installing a computer interface board. Dependent variables included achievement on learning verbal information, concrete concept learning, and rule learning. College students were randomly assigned to one of six treatment groups, combining two forms of objectives conditions, with orienting objectives and without, with three forms of review conditions, computer controlled, learner controlled, and no review. Results showed that performance on total posttest scores was significantly affected by the review condition. Both computer controlled and learner controlled groups scored significantly higher than no review subjects. Differences between computer controlled review and learner controlled review were not significant, however, comparisons between means for each dependent measure found the review conditions to be significant for all dependent measures, with the computer control group performing significantly better than the no review group on all three dependent measures and the learner control group performing significantly better on only concrete concepts. Significant differences for objectives were not found. The researchers conclude that computer controlled review is an effective strategy for learning verbal information, concrete concepts, and rules; however, caution that the results not be generalized to other types of learning outcomes.

In a similar study, Hannafin and Colamaio (1987) studied the effects of variations in lesson control and practice on learning facts, procedures, and problem-solving skills when utilizing an interactive video lesson. Subjects were randomly assigned to one of three treatment groups, designer control (program control), learner control with coaching, and linear control. Posttest achievement measures determined that both program control subjects and learner control with coaching subjects achieved higher scores than the linear control group.

With regard to time-on-task and control options, Balson, Manning, Ebner, and Brooks (1985) compared instructor control to student control in an interactive videodisc lesson on administering intramuscular injections. Results determined that the instructor control group required less instructional time than the student control group. No differences were found for achievement, leading the researchers to conclude that the instructor controlled lesson was more efficient.

Milheim (1988/1989) investigated the effects of learner versus program control of pacing and sequence in an interactive video lesson on photography, on achievement, attitude, and time-on-task. Results show that learner control of pacing produced significantly higher posttest scores and decreased time-on-task. Learner control of sequencing shows a trend toward higher achievement scores, but no significant differences, and no differences for time-on-task.

Using a Spanish language instructional interactive videodisc, Verano (1987) examined the effects of three treatment modes, linear, segmented, and interactive, on achievement, retention, and attitudes toward instructional method. The linear group (control group) watched the videodisc in a passive manner, while the segmented group viewed the same material with the addition of inserted questions and minimal feedback. The interactive group was also presented the same material, but with the addition of questions and extensive feedback. Scores for the achievement and retention measures were significantly higher for the interactive group. Also, the segmented group scored significantly higher than the control group on the posttest achievement measure but not on the retention measure. The researcher concludes that interactivity was the critical factor responsible for the superior achievement of the interactive instruction group.

Raja (1988) conducted a study that examined the effects of locus of instructional control and gender pairing on achievement, attitudes, and subject interaction utilizing an interactive video science lesson. Middle school students were paired with a partner of either the same or opposite sex and randomly assigned to one of two lesson control treatments, learner-paced or lesson-paced. Results indicate significant instructional control treatment effects for achievement and instructional time, with learner control subjects. Also, there were significant differences for gender by treatment effect. For females and males, homogeneous gender pairing with learner control was the optimal condition for achievement and attitude.

Heterogeneous gender pairing produced the most incidents of competition and aggressiveness, as measured by frequency of management, social, task, and content interactions during the lesson.

Shyu (1992/1993) investigated the effectiveness (knowledge gained, attitude, and efficacy) and efficiency (time required to learn) of learner control and program control on procedural learning using interactive video. A convenience sample of undergraduate college students were randomly assigned to program or learner control treatments using a videodisc lesson to teach the procedure for making an origami (paper-folded) animal. Two sub-treatments were also randomly assigned to the subjects, prior knowledge group and novice group. Subjects in the prior knowledge group received video instruction in the making of an origami animal different from the origami animal presented in the interactive video lesson. After video instruction of the procedural task, these subjects were considered to have prior knowledge of the task to be learned from the interactive videodisc lesson. The subjects in each treatment group were measured as to performance, time to completion, postinstruction self-efficacy, and attitude. Results of the study indicate that the subjects in the learner control group achieved significantly greater performance and self-efficacy, and had superior attitudes toward instruction. Shyu (1992/1993) also has determined that subjects in the program control treatment condition used time more efficiently than subjects in the learner control treatment condition. The researcher concludes that learner control was superior to program control when learning a procedural task with interactive video.

These few studies illustrate the need for further research with interactive video and learner control options. Reeves (1993) contends that many learner control computer-based research studies, ranging from studies using simple tutorials to studies involving complex learning environments, fail to live up to theoretical and methodological guidelines. Williams (1993) in a comprehensive review of learner control research indicates that the majority of previous research with learner control has been conducted with drill and practice or tutorial programs, and little with interactive media.

Anxiety

Anxiety is a psychological construct and for the most part, a 20th century phenomenon. Anxiety was not recognized as a distinct human characteristic until Freud (1936) proposed "angst" as a discrete clinical syndrome in 1895. Freud (1936) sees anxiety as a "uniquely unpleasant feeling state, accompanied by certain specific efferent phenomena and the perception thereof" (p. 70). Anxiety, in the Freudian conceptualization, began with the traumatic experience of birth and was the "fundamental phenomenon and the central problem of neurosis" (Freud, 1936, p. 85). For Freud, this unpleasant emotional state includes experiential, physiological, and behavioral components.

Prior to 1950, there was relatively little research on human anxiety (Spielberger, 1966). Four landmark publications in 1950 are credited by Spielberger (1966) with stimulating experimental research on anxiety: May's The Meaning of Anxiety, Mowrer's Learning Theory and Personality Dynamics, Anxiety, edited by Hoch and Zubin, and Personality and Psychotherapy, by Dollard and Miller. It is interesting to note that May, in 1950, analyzed anxiety as a characteristic of modern times, due to pressures for social change brought by rapid scientific and technological advances. Since 1950, research on human anxiety has steadily increased, with over 3,500 anxiety-related research publications between 1950 and 1966 (Spielberger, 1966). This trend has continued to the present day, facilitated by conceptual advances clarifying anxiety as a theoretical construct (Spielberger, 1983).

State-Trait Anxiety Theory

The conceptual distinctions between anxiety as a transitory emotional state and as a relatively stable personality trait were first proposed by Cattell and Scheier (1961) and have been elaborated by Spielberger (1966, 1972), a well-known researcher and theorist. Anxiety most often describes an "unpleasant emotional state, characterized by subjective feelings of tension, apprehension, and worry, and by activation or arousal of the autonomic nervous system"

(Spielberger, 1972, p. 482). This anxiety state is often transitory, evoked by stimuli that a person perceives to be harmful, dangerous, or threatening. State anxiety, referred to by Spielberger (1966) as A-State, can vary in intensity and change as the amount of perceived stress changes in an individual.

Anxiety can also be referred to as "relatively stable individual differences in anxiety-proneness as a personality trait" (Spielberger, 1972, p. 482). In contrast to state anxiety, trait anxiety or A-Trait, is not directly manifested in behavior, but may reflect the frequency and intensity of state anxiety. Individuals with a stronger trait anxiety are more likely to experience heightened levels of state anxiety in situations perceived to be threatening.

Spielberger's (1966, 1972) theory of anxiety emphasizes the role of individual differences and cognitive factors in the arousal of anxiety as an emotional state. State-trait theory acknowledges that stress produces anxiety reactions. Spielberger (1972) views the sequence of cognitive, affective, and behavioral responses that result from stress as anxiety-as-process. This process may be initiated by a stressful external stimulus, or by an internal stimulus that the individual interprets as threatening. As the individual cognitively appraises the perceived threat, a state anxiety reaction occurs or intensifies. As the increase in state anxiety becomes unpleasant, the individual may cognitively reappraise the stressful situation and initiate coping behaviors to escape from the state anxiety producing situation. When unable to cope with the stressful situation, the individual may use psychological defenses to cope with or reduce state anxiety.

State-trait anxiety theory is based on stress as the initial stimulus in producing anxiety in the individual. Spielberger (1972) defines stress as "environmental conditions or circumstances that are characterized by some degree of objective physical or psychological danger . . . including spontaneously occurring variations in environmental conditions or experimental manipulations introduced by an investigator to create a stressful situation" (p. 488). Whether or not a situation is perceived as stressful depends on the individual's subjective appraisal of the situation. A situation that is objectively nonstressful can be perceived by an individual as threatening. Spielberger (1972) proposes in state-trait theory that threat be used to describe the individual's subjective appraisal of situational danger. The theory prescribes that the appraisal of a situation as threatening is determined by individual differences in aptitudes, skills, personality traits, and past personal experience with similar situations. While other anxiety theorists have tended to ignore the role of individual differences in state anxiety (Lazarus, 1966; Tomkins & Izard, 1965), Spielberger (1972) emphasizes individual differences in anxiety-proneness and vulnerability to stress, concluding that a comprehensive theory of anxiety must address individual differences.

Spielberger (1972) identifies the fundamental constructs of anxiety theory as stress, threat, state anxiety, and trait anxiety, and developed the State-Trait Anxiety Inventory (STAI) as a self-report scale to measure state and trait anxiety (Spielberger, Gorsuch, & Lushene, 1970). The primary attributes evaluated by the state anxiety scale are feelings of apprehension, tension, nervousness, and worry in a specific situation; whereas, the trait anxiety scale evaluates anxiety as an enduring personality trait. Measures of the autonomic nervous system have also been used to determine the physiological components of state anxiety, including galvanic skin response, changes in heart rate, respiratory rate, and blood pressure, muscle action potential, and palmar sweating (Lader & Marks, 1971; Levitt, 1967; McReynolds, 1968).

The state anxiety scale of the STAI has been found to be a sensitive indicator of changes in transitory anxiety induced by stressful experimental conditions, and in real-life situations that are anxiety producing, such as job interviews, important school tests, dental treatments, or approaching surgery. The trait anxiety scale has been used in various situations to establish levels of prevailing anxiety, such as determination of clinical anxiety, screening students for anxiety problems, and evaluating outcomes of counseling or drug treatment programs (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

Many studies with surgical patients have shown the sensitivity of the state anxiety scale to environmental stressors. In general, state anxiety scores in patients rise immediately prior to surgery and decline as the patient recovers; whereas, trait anxiety scores remain basically the same before and after surgery (Spielberger, Auerbach, Wadsworth, Dunn, & Taulbee, 1973). These studies in particular, support Spielberger's theory of the differentiation between anxiety as a transitory emotional state and anxiety as a relatively stable personality trait.

Anxiety and Educational Research

Anxiety as a psychological variable has been investigated extensively in educational research. The vast literature examining the effects of anxiety on academic performance indicates that anxiety can interfere with the learning process (Sarason & Palola, 1960; Spielberger, 1966). Sieber, O'Neil, and Tobias (1977) reviewed research on the effects of anxiety on learning in several settings, including traditional instruction and computer-based instruction, and determined that anxiety interfered with achievement across instructional environments. In early studies at Duke University, Spielberger (1966) determined anxiety levels of college students and reported that over 20% of students, described as highly anxious, dropped out of school due to academic failure. Of the college students in the low anxiety group, only 6% quit school. The general result of the interference of anxiety in the learning process is that the student's achievement is not commensurate with his or her intellectual aptitude.

Ruebush (1963) identifies test anxiety and math anxiety, and Cambre and Cook (1985) identify computer anxiety, as three specific anxiety manifestations with potential similarities in the educational environment. Sarason (1972) identifies test anxiety as "a proneness to emit self-centered, interfering responses when confronted with evaluative conditions" (p. 383). Mandler and Sarason (1952) published the first study relating the effects of test anxiety on learner achievement and since that study many researchers have examined the identification, measurement, . and treatment of test anxiety. Tyron (1980) has reviewed the literature regarding test anxiety and determined that test anxiety is related to two factors, worry and emotionality. Worry inhibits academic performance, whereas emotionality is unrelated to performance. In her review of the literature, Tyron (1980) reports that small but significant correlations were found between test anxiety scores and college grade point average, course grades, and various aptitude and achievement tests.

In medical education, several researchers (Kohn & Frazer, 1986; Lloyd & Gartrell, 1983; Wolf, Faucett, Randall, & Balson, 1988) have identified test anxiety as one of the greatest stressors for medical students. Pablo, Subira, Martin, Flores, and Valdes (1990) studied Spanish medical students at the University of Barcelona School of Medicine to determine students' anxiety when taking each of two examinations in different subjects, medical psychology and physiology. Anxiety was measured by the state anxiety scale of the STAI, validated in Spanish (Spielberger & Diaz-Guerrero, 1975), administered just before the students began to answer the examination questions. The trait anxiety scale of the STAI was measured 2 days later during class and was not associated with an exam. The researchers also used analog scales to measure three other variables as appraised by the students, that included importance attributed to chance in examination scoring, relative importance of the exam based on the subject, and degree of difficulty of the exam, assessed at the end. Results determined that state anxiety increased prior to both exams, but was greater with the physiology exam than with the psychology exam. There was a positive correlation between the importance attributed to the examinations and the associated anxiety. A significant negative correlation was observed between the importance of the exam and the importance attributed to chance in scoring. The researchers concluded that test anxiety is highly variable in individuals taking exams of the same format, in the same room, but with different subject matter. This study found that the importance attributed to the exam is one variable that determines the level of anxiety. This supports Spielberger's (1972) theory of state-trait anxiety as an emotional process, which maintains that perceived stress is the initial cue that triggers the state anxiety reaction.

Math anxiety has also been studied extensively by researchers. Richardson and Suinn (1972) developed the Mathematics Anxiety Scale to measure math anxiety and described math anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematics problems in a wide variety of ordinary life and academic situations" (p. 551). Resnick, Viehe, and Segal (1982) studied determinants involved in math anxiety and identified three prevalent factors, evaluation anxiety, arithmetic computation anxiety, and social responsibility anxiety. In a review of the math anxiety research literature, Betz (1977) reported that math anxiety has been found to correlate with gender, prior math exposure, math achievement, trait anxiety, test anxiety, students' attitudes toward math, and parents' and teachers' attitudes toward math.

In recent years, researchers have attempted to extend the knowledge of the impact of anxiety on learning by investigating the relationships between anxiety and learning with the computer. Cambre and Cook (1985) propose that computer anxiety is comparable to test anxiety and math anxiety as a situational manifestation of the general anxiety construct. Rohner and Simonson (1981) describe computer anxiety as "the mixture of fear, apprehension, and hope that people feel when planning to interact or when actually interacting with a computer" (p. 551). Based on Spielberger's (1966) state-trait anxiety theory, Raub (1981) reports that a greater proportion of high trait anxiety individuals will experience state anxiety reactions when confronted with computers and further hypothesized that an individual's level of computer anxiety may change over time, but may be dependent on the level of trait anxiety. Computer anxiety can occur even when the situation poses no immediate or real threat, therefore, Cambre and Cook (1985) conclude that computer anxiety is probably an anxiety state rather than an anxiety trait. R. E. Clark (1984), in reviewing research with computer-based instruction, points out that efforts to alleviate computer anxiety have largely failed, with anxiety researchers now looking for ways to circumvent, rather than cure, computer anxiety.

Tobias (1979) recommends instructional design features such as ample opportunity to review instructional materials, shorter steps, use of good examples, a high degree of embedded organization, and constant feedback on progress to reduce the cognitive load for the anxious learner. R. E. Clark (1984) emphasizes that these methods will not reduce anxiety in the learner, but rather assist the learner through the instructional process while avoiding anxiety-producing steps.

Anxiety and Interactive Video

Studies that examine the effects of state anxiety when learning with interactive video have not been done. A comprehensive review of the literature discloses one research study that examines computer anxiety and interactive video, but unfortunately this study is a gross media comparison study (Overbaugh, 1993). There are several reasons that this variable has been largely ignored. Interactive video is a relatively new instructional medium in education and has not been readily affordable or available. As research with interactive video began, investigators were primarily concerned with determining whether or not an achievement effect existed for instruction with interactive systems. Further, researchers attempted to report the achievement differences between interactive video and traditional forms of instruction. Later, research with interactive video began to evolve with studies that focused more on design elements of the instruction, learner characteristics, and cognitive processing of the learner.

Research is needed that examines the effect of anxiety in the learner when using an interactive video lesson. Alpert and Haber (1960) emphasize that to evaluate efficacy of instruction, educators must be cognizant of the relationship between anxiety and instruction, and study how to identify and measure anxiety in achievement situations, so that we may further determine how to assist the anxious student. Reiser (1980) concurs by indicating that researchers should measure anxiety in their studies to have a better understanding of how anxiety interacts with other learner characteristics and the possible effects on the learning outcome.

Anxiety and Cognitive Style

Much of the research with anxiety and cognitive style has focused on stress as a personality variable. Fewer studies have been done to examine anxiety and cognitive style in academic environments. A recent study by Ismail and Kong (1985) analyzed the relationships between locus of control, cognitive style, anxiety, and academic achievement, while controlling general intellectual ability in 375 primary school children. The state and trait scales of the STAI were used to measure both types of anxiety. The Children's Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971) was used to measure cognitive style. Measurement of general intellectual ability and locus of control was obtained, as well as scores for academic achievement based on test results. The researchers determined that each of these variables are individually related to academic performance. Regression analyses indicated that even with the presence of general intellectual ability, locus of control was the most significant predictor of academic achievement, followed by state anxiety, cognitive style, and trait anxiety. The group of students with low state anxiety demonstrated better academic performance than students with high levels of state anxiety. With regard to trait anxiety, there were no significant differences in academic performance of students with either high or low levels of trait anxiety. These findings are consistent with state-trait anxiety theory. The researchers encourage further studies to examine the variables associated with academic performance, especially for learners who are externally oriented, experience high anxiety or are field-dependent.

As stress is the initial factor in state anxiety reactions, studies examining the relationships between stress and cognitive style are relevant. Korchin (1986) has reviewed several studies relative to cognitive style and stress and determined that field-dependent individuals were more affected by stressful materials than neutral materials and were more likely to forget prior learned stressful material versus neutral material. Quinlan and Blatt (1972) report that field-independent student nurses performed better and experienced less stress in a surgical nursing rotation, which is a highly structured primarily nonpersonal environment, whereas field-dependent student nurses performed better and experienced less stress in a psychiatric nursing rotation, a loosely structured interpersonal task.

Anxiety and Locus of Control

A number of investigators have studied locus of control and anxiety both as a psychological variable and an educational variable. For example, Stotland and Blumenthal (1964) have determined that individuals who are made to feel in control tend to be less anxious than those who do not believe they are in control. In their study, subjects were led to believe that a battery of tests would be administered, with half of the subjects given a choice of the order in which the tests were to be taken. The other half of the subjects were not given a choice. Those subjects given no choice demonstrated increased levels of state anxiety, leading the researchers to conclude that absence of control increased anxiety. In a similar study of a shock-avoidance experiment using college males, DeGood (1975) demonstrated that merely allowing subjects to choose the time of their rest periods between experimental sessions reduced anxiety more than for subjects allowed to rest at times selected by the researcher. These studies have shown that the absence, or even the perceived absence, of control increases state anxiety.

In education, anxiety and locus of control are often examined with regard to the effect on achievement. Allen, Gait, and Cherney (1974) studied the effects of locus of control, trait anxiety, and state test anxiety on academic performance in a personalized system of instruction course. The course format emphasized student control over the rate of instruction. Locus of control and trait anxiety were measured during the first class and state anxiety was measured immediately before each exam. Results indicated that students with an external locus of control earned lower grades and reported more state anxiety than did internally controlled students. Trait anxiety produced no significant differences for either internal or external loci of control. However, a steady and significant reduction in state anxiety was reported throughout the semester for both groups. The researchers speculated that courses that allow student control of pace alleviate anxiety more than traditional courses of instruction.

Locus of control strategies and the effects on anxiety have been investigated in a number of research studies. Coorough (1990) examines the effects of three locus of control strategies on anxiety and achievement in a CAI lesson on the effects of alcohol in the human body. College students were randomly assigned to program control, learner control, or learner control with advisement lesson control strategies, with assessment of state anxiety before, during, and after the CAI lesson. Results indicated that there were no significant achievement differences in treatment groups and no significant impact on state anxiety. However, state anxiety levels decreased with each measurement in all locus of control strategy groups. The researcher concluded that locus of control strategies may not be an important factor in student state anxiety levels, because students with high levels of state anxiety and low levels of state anxiety did not differ in performance.

In a study that found a relationship between learner control and anxiety, Hansen (1972) randomly assigned college students to three treatment groups, no feedback, feedback, and learner control, for a CAI lesson on xenograde systems, an imaginary science. The no feedback group received no information regarding correctness of test answers during the lesson. The feedback group received the words "true" or "false" following each response, plus a statement of the rule governing the correct response. The learner control condition allowed the subjects to choose whether or not to receive the "true-false" feedback, whether or not to view the rule, and when to terminate instruction. Four state anxiety measures were taken throughout the lesson. Concerning state anxiety, both the learner control and the feedback groups demonstrated decreased state anxiety across the measurement occasions. The no feedback group remained relatively high in state anxiety. Learner control subjects decreased more in state anxiety than did the subjects with feedback or no feedback. The researcher concluded that providing learners with control of instruction decreases state anxiety levels.

In a study comparing the effects of learner control of sequence of module instruction in a CAI course, Gallagher, O'Neil, and Dick (1971) determined trait anxiety and randomly assigned students to control or fixed sequence treatment conditions. State anxiety was determined prior to instruction and upon completion of instruction. For anxiety, students low in trait anxiety in the learner control condition reported the most reduction in state anxiety. Students with high trait anxiety did not appear to benefit from reduction in state anxiety in either the learner control or fixed sequence conditions. The researchers conclude that learner control of sequence may be beneficial for state anxiety reduction in learners with low trait anxiety, but would not be helpful for learners high in trait anxiety.

Summary

Through innovative technology that engenders interaction, videodisc is coming of age as an educational tool. Claims for positive effects for interactive video are generally found in increased learning performance, reduced learning time, cost effectiveness, and positive learner attitudes. However, Clark (1983) cautions that the majority of media research designs are comparative in nature and subject to confounding variables, producing few useful outcomes for generalization to educational settings.

Hannafin, Phillips, and Tripp (1986) maintain that the effectiveness of interactive video as an instructional technology remains to be proven. Many of the research studies previously conducted have focused on the technological component of interactive video, rather than the interactive component. Educators need empirical evidence as to the effectiveness of learning with interactive video and further understanding of the interaction with the learner.

Accommodating individual differences is an important agenda for educators and interactive video provides a rich technological environment amenable to the learner. With computer-based instruction, such as interactive video, learners may be given control over learning strategies, allowing for individual learning requirements. Locus of control strategies have been studied extensively in the literature, generally supporting learner control over program control as a benefit to the learner (Carrier, Davidson, &

Williams, 1985). However, evidence of support for learner control for differential types of students is conflicting (Hannafin, 1984; Snow, 1980). Carrier (1984) and Snow (1980) emphasize that further research is needed to determine which types of students will benefit from control over instructional strategies.

There are considerable individual differences in the perception of control that require further study, because each learner has a preferred method for processing information (Rotter, 1966). This preference or cognitive style, is a key element in the learning process. Cognitive style, on a continuum of field-dependence to field-independence, may help to predict learner behaviors under different locus of control strategies. Studies have shown . that field-dependent learners are less able to organize information internally and need structured mediation to facilitate performance (Carrier, 1984). Interactive video has the potential to adapt instructional content and mode of presentation to assist in information processing for either the field-dependent or field-independent learner. However, there exists a lack of research on how to best design instruction based on the interaction of locus of control strategies and learner attributes.

Previous research with computer-assisted instruction has shown anxiety to be an important learner attribute that effects learning outcome (Tobias, 1979), but has yet to be studied with interactive video instruction. Spielberger

(1966) has determined that state anxiety, due to its transitory characteristics, can decrease achievement when learning with computers. Researchers have examined further the interaction effects of locus of control strategies and anxiety on achievement with computer-assisted instruction, generally finding that learner control reduced state anxiety (Hansen, 1972). Research utilizing interactive video lessons, examining the effects of anxiety, is needed to provide further empirical evidence for the use of interactive video in education.

Interactive video creates a learning environment rich with alternatives. Interactive technology is capable of spanning language, socioeconomic and cultural barriers, and conforming to individual differences, involving the learner in the learning process. The vast technological applications of interactive video have been explored from the military to medicine. Medical educators share expertise through this technology which allows practice of clinical techniques, decision-making and patient management, exploration of ethical concerns, and even using a light pen as a scalpel. Further research with interactive video will assist educators and instructional designers to better understand the relationships between locus of instructional control strategies, cognitive style, and anxiety, redirecting our efforts from extolling the wonders of the technology to focusing on the nature and process of the interactivity.

CHAPTER 3
METHODOLOGY

The purpose of this study was to determine the interaction effects of cognitive style and locus of control strategies on learner achievement and anxiety when using an interactive videodisc lesson. This chapter presents the experimental methods and procedures followed. Chapter 3 is divided into the following sections: (a) subject selection, (b) instrumentation (Group Embedded Figures Test, State anxiety scale, pretest and posttest measurement), (c) instructional content, (d) locus of control treatments (program control and learner control), (e) interactive videodisc design and development, (f) procedures (study setting, cognitive style assessment, state anxiety scale assessment, pretest procedures, posttest procedures), (g) experimental design, and (h) data analysis procedures.

Subject Selection

Study subjects were 69 second-year medical students from the School of Medicine at Wayne State University. Students in this midwestern medical school are representative of the general medical school population in the United States, as evidenced by the statistics comparing the national applicants and matriculants for 1991 (Association of American Medical Colleges, 1991) with the Wayne State University School of Medicine 1991 applicants and matriculants. See Table 3-1.

Table 3-1
Applicants and Matriculants 1991: National and Wayne State University

APPLICANTS and MATRICULANTS	UNITED STATES of AMERICA		WAYNE STATE UNIVERSITY	
Male applicants	19,601	(59%)	1,676	(60%)
Female applicants	13,700	(41%)	1,106	(40%)
Male matriculants	10,152	(60%)	130	(53%)
Female matriculants	6,726	(40%)	115	(47%)
GPA matriculants	3.4		3.4	
MCAT matriculants	9.2		8.3	
RACE/ETHNIC BACKGROUND (Self-description)				
White	11,818	(70%)	172	(70%)
Black	1,193	(07%)	32	(13%)
American Indian/ Alaskan Native	93	(0.6%)	0	(0%)
Mexican American/ Chicano	327	(02%)	2	(0.8%)
Puerto Rican (mainland)	125	(0.7%)	1	(0.4%)
Asian/ Pacific Islander	2,778	(16%)	34	(14%)
Puerto Rican (commonwealth)	208	(01%)	0	(0%)
Other Hispanic	336	(02%)	4	(02%)

Second-year medical students (N = 225) were requested to voluntarily complete the Group Embedded Figures Test (GEFT) to determine cognitive style, either field-independent, field-moderate, or field-dependent. Seventeen students chose not to participate and 208 students completed the GEFT. Of 208 students completing the assessment, 15 students did not enter his or her name on the GEFT, leaving a total of 193 identified students. There were 114 male students and 79 female students completing the assessment. Results of the Group Embedded Figures Test are presented in Table 3-2.

Table 3-2
Group Embedded Figures Test (GEFT) N = 193

Gender: N = 193	Field-Dependent: Score 0-10	Field-Moderate: Score 11-14	Field-Independent: Score 15-18
Female N = 79	N = 16	N = 19	N = 44
Male N = 114	N = 13	N = 16	N = 85
Total N = 193	N = 29	N = 35	N = 129

The Group Embedded Figures Test was scored and the results were arranged in the following groups: (a) score 0-10, field-dependent; (b) score 11-14, field-moderate; and (c) score 15-18, field-independent. The group of students' scoring in the middle range of the GEFT were named field-moderate for purposes of this study. Research with this identified strata has not been previously done. Stratified random sampling was used to establish a representative group. Each group was separately sampled to yield a more representative sample and to avoid a one-sided biased sample (Schefler, 1984). Twenty-eight subjects from each group were randomly selected via a table of random numbers to participate in the study. Study subjects randomly selected (N = 84) were requested to voluntarily participate in the study with 69 subjects ultimately participating in the research study. Study subjects received a free pizza coupon in exchange for his or her participation. Subjects were randomly assigned, within cognitive style, to one of two treatment conditions, program control or learner control. A statement of the purpose of the study, time required, assessment procedures, and a consent form was presented to the study subjects before they participated in the research. Approval for the use of human subjects in this study was obtained from the Wayne State University Institutional Review Board and the University of Florida Institutional Review Board.

Instrumentation

Group Embedded Figures Test

The Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971) was designed as an adaptation of the Embedded Figures Test (Witkin, 1950) to make possible group testing in research situations. The individually administered Embedded Figures Test (EFT) is impractical where large numbers of subjects must be tested. The Group Embedded Figures Test (GEFT) scores may be obtained in a single 20-minute session.

The EFT is a perceptual test measuring cognitive style, more specifically, the field-dependent-independent dimension of cognitive functioning. The subject's task is to locate a previously seen, simple geometric figure which is now embedded in a larger complex figure. The simple and complex figures used in the EFT are modifications of figures used by Gottschaldt in 1926 in his classical studies of the relationships of contextual factors and past experience in perception (Witkin, Oltman, Raskin, & Karp, 1971). The original EFT contains 24 pairs of simple and complex figures, providing a measurement of the characteristic labeled by Witkin (1950) as field-dependent or field-independent.

Study of the EFT by Witkin (1961), reports high correlations with scores based on tests of body orientation (the Tilting Room-Tilting Chair Test, Rotating Room Test, and the Rod and Frame Test), indicating that these procedures make similar demands upon subjects. The subjects who do well with the test, have the ability to analyze a complex configuration and then respond to some parts, ignoring others. Subsequent studies (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962) show that this ability is related to temperament and personality characteristics. Field-dependent persons, those having greater difficulty with the EFT and the body orientation tests, were found to be more passive and anxious about control of body impulses, with lower self-esteem, and with less well-differentiated body images. Females generally score significantly more field-dependent than males in the general college population. Gough (1965) advises that the EFT not be interpreted as an index of general ability, but rather as a diagnostic test for "(a) field independence, (b) cognitive clarity, (c) an analytic versus global perceptual mode, and (d) a general disposition to articulate and structure experience" (p. 210).

Since 1950, when Witkin's first paper was released on the EFT, much research has been done to establish validity and reliability. Gough (1965) believes that one of the most appealing features of this test is its "firm anchoring in a systematic context of theory and empirical evidence" (p. 210). Test-retest coefficients for males and females (N = 102), even with a 3-year interval between administrations, were reported at .82 for college males and .79 for college females (Witkin et al., 1971). Stability coefficients over shorter intervals, whether by odd-even, test-retest, or analysis of variance method, are even higher, with a median coefficient in 10 studies reported to be .905 (Gough, 1965). The instrument has been used in over 3,000 research studies prior to 1980, as a measure of cognitive style (Cox, 1980).

The GEFT was modeled as closely as possible to the EFT with respect to method of presentation and format (Witkin et al., 1971). The GEFT contains 18 complex figures, 17 of which are from the EFT. As with the EFT, the subject is prevented from seeing the simple figures and the complex figures at the same time. The simple figures are printed on the back of the GEFT booklet and the complex figures are printed on the booklet pages. The subject may look back at the simple figures as often as he or she wishes, as with the EFT. The GEFT contains three sections consisting of seven, nine, and nine items. The time limits are 2, 5, and 5 minutes respectively. The basic instructions given to the subjects are to find a specified simple figure in each of the complex figures. The subject is asked to trace the simple figure in the complex figure, using a provided soft pencil.

The first part of the test is not scored, but designed for subject practice and to allow the examiner a screening device for comprehension of directions. The total number of simple figures correctly traced in the second and third sections combined is the raw score for the GEFT, thus providing a range of scores from 0-18. Omitted items are scored as incorrect. In order to receive credit for an item, all lines of the simple form must be traced. The GEFT manual gives specific instructions for administration of the test and for use of the scoring key provided with the test (Witkin et al., 1971).

The reliability of the GEFT was measured by the correlation between the scores on the second and third sections, both nine items each with a 5-minute time limit. Corrected by the Spearman-Brown prophecy formula, a reliability estimate of .82 for both male (N = 80) and female (N = 97) college students was obtained.

Construct validity data were established by three sets of correlation coefficients, based on separate groups of male and female college students. The three criterion variables used were the Embedded Figures Test (the parent form of the GEFT), the Rod and Frame Test (RFT), which is a measure of field-dependence-independence used to establish validity of the EFT, and the degree of articulation of the body concept scale (ABC scale), which is another measure of psychological differentiation. The correlations between the GEFT and the EFT are .82 for college males (N = 73) and .63 for college females (N = 68). Correlations between the GEFT and the RFT are lower, -.39 for college males (N = 55) and -.34 for college females (N = 68). The numbers are comparable to the range of correlations typically found between the EFT and the RFT. The correlations with the EFT and the RFT are negative because the tests are scored in reverse fashion. The correlations between the GEFT and the ABC are .71 for college males (N = 55) and .55 for college females (N = 68), which are comparable to correlations with the EFT and the ABC.

Witkin et al. (1971) also report normative data for college students, both male and female. For college males (N = 155), the mean for the GEFT was 12.0 with a standard deviation of 4.1, and for college females (N = 242), the mean was reported to be 10.8 with a 4.2 standard deviation.

Goodstein (1978) in evaluating the instrument, found the GEFT to be a "well-conceptualized and well-researched instrument . . . for research purposes for screening on the field-dependence-independence dimension" (p. 838). Hall (1978) also evaluated the GEFT and found the instrument to be a useful group version of the EFT for cognitive style research, but should be used for research purposes only until more technical data is available. Witkin et al. (1971), the developers of the GEFT, believe the instrument to be an effective substitute for the EFT when individual testing is impractical, but also caution that the test must still be considered a research instrument until more extensive construct validation data are collected from a wider variety of groups.

State Anxiety Scale

The S-anxiety and the T-anxiety scales comprise the State-Trait Anxiety Inventory (STAI). Both are self-report instruments, consisting of 20 statements each. The state anxiety scale evaluates how subjects feel "right now, at this moment." The T-anxiety scale evaluates how subjects "generally" feel. The title printed on the test booklet is the Self-Evaluation Questionnaire. State anxiety has been shown to be more strongly associated with learning and achievement than is trait anxiety (Head & Lindsey, 1983; Sewell, Farley, & Sewell, 1983). For purposes of this research, only the S-anxiety scale was administered.

The state anxiety scale (S-anxiety scale) of the State-Trait Anxiety Inventory (STAI) Form Y (Spielberger, 1966) was used to assess the subject's perceived level of anxiety prior to and immediately after the interactive video learning task. The measurement of anxiety as learning progresses enables the researcher to determine the nature of the relationship between anxiety and learning. The measurement of state anxiety reflects the reaction of the subject to a particular stress-inducing stimulus, such as learning with interactive video.

The essential characteristics evaluated by the STAI S-anxiety scale are feelings of tension, apprehension, nervousness, and worry (Spielberger, 1983). Scores on the

S-anxiety scale increase in response to danger or stress and decrease with relaxation. The S-anxiety scale, widely used in research settings, has been found to be a sensitive indicator of changes in transitory anxiety (Spielberger, 1983).

The S-anxiety scale was designed to be self-administered and may be given individually or to groups. The instrument has no time limits. College students generally require 6 minutes to complete the S-anxiety scale. Repeated testing typically requires 5 minutes. Spielberger (1983) advises that subjects will respond more objectively and accurately if they are promised that their scores will remain confidential and if they are promised feedback about the test results. Critical to the validity of the test is that the subjects understand the S-anxiety scale instructions, which require them to report how they feel "right now." For research purposes, it is acceptable to use the S-anxiety scale to focus on a particular time period and to assess anxiety changes over time. The research subjects may be instructed to respond to how they feel prior to performing the experimental task and again to how they feel after completing the experimental task.

The S-anxiety inventory, Form Y, consists of 20 items with directions for answering in terms of how the subject feels at the present moment. The subjects rate themselves on a 4-point scale that best describes the intensity of their feelings. The responses consist of (a) not at all,

(b) somewhat, (c) moderately so, and (d) very much so. Statements such as "I am tense," or "I feel nervous," are worded so that a rating of four indicates a high level of state anxiety. Other statements such as "I feel calm," or "I feel steady," are worded so that a high rating indicates less or an absence of state anxiety. Scoring weights for items measuring high state anxiety range from 1 to 4 (for example, very much so = 4 points; not at all = 1 point). For items measuring low or an absence of state anxiety, scoring weights are reversed (for example, very much so = 1 point; not at all = 4 points). To determine the state anxiety level, the weighted scores of the 20 items are summed. The range of possible scores for the state anxiety scale is 20 to a maximum of 80.

The State Trait Anxiety Inventory has been used extensively in research since its introduction in 1966. Spielberger (1983) reports alpha reliability coefficients for the S-anxiety measure to be .91 for college males (N = 296) and .93 for college females (N = 481). The mean score for college males was reported to be 36.47 with a standard deviation of 10.02. For college females, the mean score was 38.76 with a standard deviation of 11.95. Spielberger (1983) also reported test-retest correlations for the S-anxiety scale to be relatively low, ranging from .16 for college females (N = 109) at 1-hour test-retest interval to .54 for college males (N = 38) at 20 days test-retest interval. Low stability coefficients were expected because a measure of state anxiety would reflect situational factors at the time of testing. Further evidence of internal consistency is provided by item-remainder correlations computed for normative samples. The median S-anxiety item-remainder correlation was .54 for college males (N = 296) and .60 for college females (N = 481).

Spielberger (1983) determined construct validity of the STAI S-anxiety scale through contrasted groups. Scores of military recruits, tested shortly after beginning stressful training programs, were much higher than college students of about the same age tested under nonstressful conditions. Mean anxiety scores for the stressed male (N = 1,893) and female (N = 71) military recruit were 44.05 and 47.01, respectively, while scores for nonstressed male college students (N = 324) were 36.47 and female (N = 531) scores were 38.76. The S-anxiety scores were also much higher than their own T-anxiety scores, which suggests that the recruits were experiencing a high level of stress and anxiety when they were tested. Spielberger (1983) found further evidence of the construct validity of the S-anxiety portion of the STAI by determining that the scores of college students were significantly higher under exam conditions than under normal conditions. College males (N = 332) reported a mean S-anxiety score of 40.02 under normal conditions and 54.99 under exam conditions. College females' (N = 645) mean anxiety score for normal conditions was 39.36, as compared to 60.51 under exam conditions.

Dreger (1978) in reviewing the STAI, concluded that the instrument "is one of the best standardized of anxiety measures, if not the best" (p. 1095), with high reliabilities, demonstrating expected differences among groups of people. Katkin (1978) concurs, adding that the STAI is an "efficient, reliable, and valid way to assess individual differences in anxiety-proneness" (p. 1096) with voluminous research literature attesting to its validity and reliability. The test manual for the STAI (Spielberger, 1983) provides explicit instructions for administration and scoring of the instrument and an extensive bibliography of research in which the STAI was used to measure anxiety. Spielberger (1983), the test author, complied a comprehensive bibliography of over 2,000 research publications in which the STAI was used before 1980.

Pretest and Posttest Development

The criterion pretest/posttest measurement was developed by a panel of experts from the fields of curriculum and instruction, anatomy, neurology, and neurosurgery. Thirty-two questions were presented to the expert panel for review, including embedded questions from the neuroanatomy lesson. Two questions were discarded and the remaining 30 questions were accepted or improved per the recommendations of the panel. The 30-item test was then given to 80 third-year medical students at Wayne State University. Students completed the test voluntarily without entering their names, but were asked to complete the test to the best of his or her ability. An item analysis was performed on each test item. Items with either negative or low item-total correlations were then omitted, resulting in a 15-item test, including eight embedded questions and seven nonembedded questions. A Kuder-Richardson 20 (K-R 20) was then computed, providing a reliability estimate of .52. The panel of test developers believed the reliability estimate to be lower than expected due to volunteer students completing the test without being graded or using their names.

Pretest and Posttest Measurements

Following test development, the criterion pretest resulted in 15 randomly ordered multiple-choice questions which tested for knowledge of content presented in the interactive video lesson. Eight questions embedded in the instructional treatments were included on the pretest; seven nonembedded content-related questions were also included. The criterion posttest was identical in style and content to the pretest, consisting of the same 15 questions arranged in a different order.

Instructional Content of the Interactive Video Lesson

The benefit for computer interactive instruction in the neurological sciences was recognized by the Joint Committee on Education of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons in 1983, with the formation of the Computer Technology Committee. This committee was to explore development of computer-assisted education and has since funded pilot projects to produce interactive videodiscs for neurosurgical instruction (MacFarlane, 1991).

The interactive videodisc selected for this research study was developed and produced by the University of Utah (Stensaas & Burrows, 1993). The videodisc is entitled Slice of Life VI and is a multi-disciplinary/multi-institutional shared disc of 38,500 images covering all areas of medical education. The videodisc contains 8,500 images specific to neuroscience education, including gross and microscopic neuroanatomy, neuropathology, neuroradiology, and 500 atlas images in 2D covering the head, neck, and spine. An index permits text search of the images and displays the image together with the title diagnosis. Students may access the atlas in three dissection planes, coronal, sagittal, or horizontal, view animated reflex diagrams or consult the glossary.

The neuroscience education software used with the videodisc was HyperBrain 5.0 for the Macintosh computer, developed by Cornell University Medical College (McVaughn & Stensaas, 1993). HyperBrain 5.0 is a HyperCard 2.1 application designed as a core resource for neuroscience education, and when used with the Slice of Life VI videodisc provides a Level-3 interactive environment. The software contains a series of 14 chapters designed to compliment, supplement, or substitute for a traditional neuroanatomy lab. The software is not intended to replace an entire neuroanatomy lab, as it is assumed by the authors that the student has previous background in neuroanatomy. Second-year students were chosen as the study population because they have had one semester of neuroanatomy during the first year of medical school. The chapters are linked to over 750 images on the videodisc, with an additional 1410 images linked to glossary terms. Each chapter is followed by a quiz with images and learning responses for each correct and incorrect answer providing another 887 image links. Practical exams are provided from a bank of 500 images randomly presented with 150 questions.

The lesson for this research study chosen from HyperBrain 5.0 was "The Regions of the Brain, the Cranial Nerves, and the Meninges" (Millhouse & Stensaas, 1993). Primary objectives of the lesson were to identify the structural divisions of the brain, the cranial nerve roots, and the meninges of the brain and spinal cord. There are three major hypertext features in the lesson. Major terms are identified by the presence of black bullets (•). For example, if the student clicks on neural tube, a brief definition will appear and an image appears on the videodisc. Another hypertext feature is the ability to go to specific frame numbers by clicking on them. For example, in looking at the divisions of the neural tube, the number 676 appears in the text that explains the mid-sagittal region of the neural tube. By clicking on the number, a mid-sagittal picture of the brain appears with different regions highlighted in color. A third hypertext feature available to the student is to click on a reference figure, for example Fig 1a, which will take you to a picture paired with a videodisc image. Also, every label on the picture is linked to its definition and a videodisc image. For example, on the right side of Fig 1a is the word pyramid. If the student clicks on the word, a cross-sectional diagram of the medulla with the pyramids colored red appears, along with a definition from the glossary. At the end of the lesson, there are suggested places the student could go for additional information, which may include review, animations, the atlas, and testing. The videodisc lesson required approximately 1 hour to complete under program control conditions.

Locus of Control Instructional Treatments

Two different locus of instructional control strategies were used with the *Slice of Life VI* videodisc and the HyperBrain 5.0 neuroanatomy lesson. The lesson control strategies were program control and learner control.

Program Controlled Interactive Video Lesson

Subjects in the program controlled condition proceeded through the interactive lesson in a linear manner, completing each section in a prescribed order. The interactive lesson consisted of elements of drill and practice, tutorials, and visual and aural simulations and demonstrations. Subjects were instructed when to view videodisc images, when to consult the atlas and glossary, when to watch appropriate animations, and were guided through a lesson review. Program control subjects practiced anatomical identification and diagnostic skills with a review quiz with feedback responses from the computer. Subjects completed the entire lesson before terminating the learning session.

Learner Controlled Interactive Video Lesson

Subjects in the learner controlled condition determined lesson sequence, need for review, and practice time by choosing any or all of the available elements of drill and practice, tutorials, and visual and aural simulations and demonstrations. Subjects controlled the decision to view videodisc images, consult the atlas and glossary, watch animations, and participate in a lesson review. Learner control subjects determined the need for practice by engaging in anatomical identification and diagnostic skills activities with a review quiz and controlled the decision to terminate the lesson.

Interactive Video Lesson Design and Development

The interactive videodisc used in this study was designed and developed by Suzanne S. Stensaas, Ph.D., Director of the Education Center, Cornell University Medical College, and by Paul Burrows, University of Utah, Department of Instructional Media Services. The team of developers for the application design for HyperBrain included Dean Sorenson, Ph.D., Steve Hart, M.D., Benjamin Kao, and Nate McVaugh. The syllabus for HyperBrain was written by O. E. Millhouse, Ph.D., of the Mayo Foundation, and by Suzanne S. Stensaas, Ph.D., of Cornell University Medical College. Material on the videodisc includes contributions from 52 different institutions, two professional societies, and over 200 individuals.

Study Procedures

The study was conducted at Wayne State University School of Medicine, an urban university in Detroit, Michigan. All procedures for data collection were conducted in Scott Hall, in the Self-Instruction Center, central to the Wayne State University School of Medicine campus.

Study Setting

The Group Embedded Figures Test (GEFT) was administered during scheduled class time in a second-year pathology course, with permission of the professors, the Dean of Student Affairs, and the students. All students understood that the test was related to a research study. Each student was assigned a study identification number and was given the opportunity to obtain results from the GEFT and other criterion measures when the data collection process had been completed.

Stratified random sampling was used to obtain a representative sample. Subjects randomly selected from each strata were identified and contacted to request their participation in the study. Study subjects were asked to read and sign an informed consent prior to participating in the study. All subjects signed up for computer lab time to complete the data collection procedures. Subjects for the study were randomly selected and randomly assigned via a table of random numbers to one of two treatment conditions identified by the preassigned study number.

Upon entering the Self-Instruction Center to complete the data collection process, the study subjects were given the appropriate study materials for the treatment condition to which he or she was assigned (learner or program controlled) and the interactive videodisc. The HyperBrain neuroanatomy lesson had been previously placed on the hard drive of all Macintosh computers in the Self-Instruction Center. Subjects in the program control treatment condition received verbal and written instructions regarding the prescribed order in which to complete each section of the lesson, major terms to explore, and participation in guided review sections. Program control subjects were also required to complete a lesson review quiz before terminating the lesson. Subjects in the learner control treatment condition also received verbal and written instructions that gave the subject complete control of the lesson. Learner control subjects were made aware of options available in the lesson, and were told to study the lesson in part or whole by determining his or her own sequence, exploration of major terms, need for guided review, and need for practice with a review quiz. Learner control subjects also decided when to terminate the lesson.

Each subject was seated individually at a computer workstation with a Macintosh IIci, configured with a color television monitor, disc drive system, videodisc player, and high resolution monitor. Computer workstations were separated to prevent discussion of content with other subjects. Prior to beginning the interactive videodisc lesson, all subjects were given an introduction to the Self-Instruction Center, the Macintosh computer, and the videodisc player. Subjects were then instructed how to begin the session, enabling them to complete the state anxiety assessments, pretest, lesson, and posttest. Demographic information was also collected including age, gender, and race or ethnic group. A computer and interactive videodisc experience questionnaire using a Likert scale was also completed by each subject.

State Anxiety Scale Assessment

State anxiety was assessed prior to administration of. the pretest. Students responded to the 10 questions by choosing one of four possible choices. Upon completion of the initial state anxiety assessment, the subject completed the pretest assessment. The subject was then instructed to begin the interactive video lesson. After completing the pretest, lesson, and posttest, the subject was again administered the state anxiety assessment in the same manner. The state anxiety assessments, pretest and posttest assessments were completed by each subject on paper using a pencil.

Pretest Procedure

The pretest was administered following the initial state anxiety assessment. Upon completion of the pretest, the subject was directed to begin the interactive videodisc lesson.

Posttest Procedure

The posttest measurement was conducted immediately following completion of the interactive lesson and prior to the administration of the post-task anxiety assessment.

Experimental Design

The independent variable in the study was locus of instructional control strategy; the moderator variables were cognitive style, grade point average (GPA), gender, and Medical College Admission Test (MCAT) score. The dependent variables in the study were anxiety and learning achievement.

A split-plot analysis of variance experimental design was used in the study for the state anxiety measures. This design consisted of two between-treatment levels (program control and learner control) and two within-treatment levels (pre-task anxiety and post-task anxiety). A pretest-posttest experimental design was used for achievement. Analysis of covariance, correlation analysis, t-test, and analysis of variance were used to further test relationships between variables.

A minimum of 28 subjects per treatment condition were sought (N = 84) to ensure adequate sample size (Polit & Hungler, 1983). All second-year students that agreed to participate (N = 208) were given the Group Embedded Figures Test to determine cognitive style (field-independent, field-moderate, or field-dependent), resulting in three groups.

Twenty-eight of each type were randomly selected from a table of random numbers. Fourteen subjects of each type were then randomly assigned to one of two treatment conditions, program control or learner control, for a total of 84 subjects in one of six possible factors. Sixty-nine of the 84 randomly selected and assigned subjects completed the data collection process (N = 69). Fifteen randomly selected subjects chose not to participate in the study. Subjects were not informed of their cognitive style, nor of the treatment condition to which he or she was assigned. All subjects received the same cognitive style assessment, the same pretest and posttest measures, the same pre-task and post-task anxiety measure, the same interactive videodisc, and the same neuroanatomy lesson. The researcher manipulated the locus of instructional control strategy through instructional design, which allowed the learner control group to determine the sequencing and pacing of instruction, the need for review, necessary practice time, and termination of the lesson. The program control group proceeded through the lesson via a predetermined path, and terminated the lesson after completing each section in order. Opportunities for pacing, review, and practice time were predetermined by instructional design. Time-on-task was measured by the researcher as the time the subject began the lesson until the time the lesson was terminated.

Data Analysis

The following statistical analyses were conducted to determine the effect of cognitive style, gender, GPA, and MCAT score, and the two treatment conditions (program control or learner control) on anxiety and learning achievement:

1. A repeated measures analysis of variance was used to determine whether state anxiety changes (pre-task and post-task) differ by treatment condition (program control or learner control). [Hypothesis 1]

2. A two-way factorial analysis of variance was used to determine the relationship between post-task state anxiety and treatment condition (program control or learner control) by cognitive style interaction. [Hypothesis 2]

3. Correlation analysis was used to determine the relationship between posttest achievement and pretest scores. [Hypothesis 3]

4. Correlation analysis was used to determine the relationship between posttest achievement and pre-task anxiety. [Hypothesis 4]

5. A t-test was used to determine the differences between treatment condition (program control or learner control) on posttest achievement. [Hypothesis 5]

6. A two-way factorial analysis of variance was used to determine the relationship between posttest achievement and treatment condition (program control or learner control) by cognitive style interaction. [Hypothesis 6]

7. Analysis of covariance was used to determine the relationship between posttest achievement, treatment condition (program control or learner control), and cognitive style with pre-task anxiety as the covariate. [Hypothesis 7]

8. A two-way analysis of variance was used to determine the relationship between posttest achievement and cognitive style by gender interaction. [Hypothesis 8]

9. A two-way analysis of variance was used to determine the relationship between pre-task anxiety and cognitive style by gender interaction. [Hypothesis 10]

10. A two-way analysis of covariance was used to determine the effects of cognitive style on posttest achievement after removing the effects of the covariates GPA, MCAT score, and pre-task anxiety. [Hypothesis 10]

11. A two-way analysis of covariance was used to determine the effects of treatment condition and cognitive style on pre-task anxiety after removing the effects of the covariates GPA and MCAT score. [Hypothesis 11]

12. A t-test was used to determine the locus of instructional control strategy that required greater time-on-task to lesson completion. [Hypothesis 12]

Summary

Chapter 3 is a presentation of the methodology designed to determine the effects of cognitive style, gender, GPA, MCAT score, and locus of instructional control strategies on learner achievement and anxiety when using an interactive videodisc lesson. Chapter 4 contains the results of the study procedures and data analysis. Chapter 5 is a discussion of conclusions and implications of the study and recommendations for future research.

CHAPTER 4
RESULTS AND DATA ANALYSIS

The purpose of this study was to determine the effects of two locus of instructional control strategies on learner achievement and anxiety as moderated by cognitive style, gender, GPA, and MCAT score. An interactive videodisc lesson was used to develop two treatment conditions, learner control and program control, to determine the effects on learning and state anxiety levels while using the interactive lesson. To test the hypotheses stated in Chapter 1, a repeated measures analysis of variance experimental design was used to examine state anxiety changes. Student achievement was compared using a pretest-posttest experimental design. Analysis of covariance, correlation analysis, and t-test were used to further test relationships between instructional control strategies, learner achievement, state anxiety levels, cognitive style, gender, grade point average (GPA), Medical College Admission Test (MCAT) score, and time-on-task. This chapter presents the results of the data analysis.

Study Subjects

Subjects who participated in this research study consisted of 69 (N = 38 males; N = 31 females) second-year medical students from Wayne State University School of Medicine in Detroit, Michigan. Stratified random sampling was used to sample subjects from all (N = 208) second-year medical students who completed the Group Embedded Figures Test to determine cognitive style. Subjects were randomly assigned within strata to one of two treatment conditions. Demographic information is reported in Tables 4-1 and 4-2. Information regarding experience with computers and with interactive video is presented in Table 4-3.

Table 4-1
Demographic Information: Gender and Age

Gender	Number	Percent	Mean Age	SD of Age
Female	31	44.9	24.6	2.3
Male	38	55.1	24.0	2.1
Total	69	100.0	24.3	2.2

Table 4-2
Demographic Information: Race/Ethnic Group (Self-Description)

Race/Ethnic Group	Number	Percent
Caucasian	44	63.8
African-American	5	7.2
Asian	8	11.6
Indian	7	10.1
Hispanic	2	2.9
Arabic	3	4.3
Total	69	100.0

Table 4-3

Computer Experience Questionnaire

Question A: Do you have a computer at home?

Computer at home?	Number	Percent
Yes	29	42
No	40	58
Total	69	100

Question B: Do you utilize the computers at the medical school for medical education (not including word processing)?

Use WSU computers?	Number	Percent
Yes	58	84.1
No	11	15.9
Total	69	100.0

Question C: When did you first use a computer for learning or instruction (computer-assisted instruction, CAI)?

First CAI experience	Number	Percent
Elementary/middle school years	24	34.8
High school years	25	36.2
Undergraduate college years	15	21.7
First/second-year medical school	5	7.2
Total	69	100.0

Table 4-3--continued

Question D: Currently, how often do you use a computer for instructional purposes?

CAI Frequency?	Number	Percent
More than 1x week	6	8.7
At least 1x week	5	7.2
At least 1x month	23	33.3
Occasionally	30	43.5
Never	5	7.2
Total	69	100.0

Question E: When did you first use a videodisc (IVD) for instructional purposes?

First IVD experience?	Number	Percent
High school years	1	1.4
Undergraduate college years	3	4.3
First-year medical school	55	79.7
Today during this research study	10	14.5
Total	69	100.0

Question F: Currently, how often do you use a videodisc and the computer for instructional purposes?

IVD Frequency?	Number	Percent
More than 1x week	3	4.3
At least 1x week	4	5.8
At least 1x month	22	31.9
Occasionally	26	37.7
Never	14	20.3
Total	69	100.0

Table 4-3--continued

Question G: Do you find videodisc instruction to be helpful in supplementing the medical school curriculum?

IVD Supplement?	Number	Percent
Very helpful	29	42.0
Somewhat helpful	36	52.2
Very little	4	5.8
Total	69	100.0

Question H: Did you find this lesson on the regions of the brain, the cranial nerves, and the meninges to be helpful?

Neuro IVD lesson helpful?	Number	Percent
Yes, learned more, liked IVD	56	81.2
Lesson helpful, don't like IVD	9	13.0
Not helpful, don't like IVD	4	5.8
Total	69	100.0

Results

The results of this research study are reported by hypothesis as presented in Chapter 1. All hypotheses were tested with a probability value of $p < .05$ to determine significance.

H1: There is no significant interaction between locus of instructional control strategies (program control or learner control) and occasion (pre-task or post-task) that affects state anxiety levels.

To test Hypothesis 1, a repeated measures analysis of variance with two between treatment levels (program control and learner control) and two within treatment levels (pre-task anxiety and post-task anxiety) was used to determine whether state anxiety changes differ by treatment condition. Means and standard deviations for the group-treatment factor and the within-subject factor are presented in Table 4-4.

Table 4-4
Means and Standard Deviations for State Anxiety Measurement Occasions by Treatment Condition and Cognitive Style

Control Strategy	Number of Cases	Pre-Task Anxiety Mean	Pre-Task Anxiety SD	Post-Task Anxiety Mean	Post-Task Anxiety SD
Learner	35	31.5	10.5	32.8	11.0
Field-D	10	29.0	8.5	29.1	9.8
Field-M	12	33.2	11.6	35.4	12.7
Field-I	13	31.8	11.3	33.2	10.3
Program	34	31.2	8.9	33.5	10.3
Field-D	8	28.3	5.2	30.2	6.2
Field-M	12	33.5	11.0	37.0	12.7
Field-I	14	31.0	8.6	32.5	9.8

A repeated measures analysis of variance of state anxiety change across measurement occasion for treatment conditions, as reported in Table 4-5, demonstrates no significant difference for the main effect of treatment, yielding an F(1,67) = .01. There was a significant main effect for the within-subject variable of anxiety measurement occasion, with F(1,67) = 4.74, p = .033. The two-way interaction of treatment by anxiety measurement occasion was not significant, reporting an F(1,67) = .33.

Table 4-5
Source Table of Repeated Measures ANOVA of State Anxiety Change Across Measurement Occasions for Treatment Conditions

Source	SS	df	MS	F	Sig of F
Between Subjects					
Treatment	2.76	1	2.76	.01	.903
Error	12445.87	67	185.67		
Within Subjects					
Occasion	110.46	1	110.46	4.74	.033
Treatment by Occasion	7.79	1	7.79	.33	.555
Error	1562.08	67	23.31		

The data does not support the rejection of H1 regarding the interaction of treatment and measurement occasion for state anxiety levels. However, the data analysis revealed a significant difference in state anxiety levels across measurement occasions. Specifically, this significant within-subject difference in state anxiety levels across pre-task and post-task measurement occasions reflects an increase in state anxiety on the second measure or post-task measure, after the interactive videodisc lesson was completed.

H2: There is no significant relationship between the interaction of locus of instructional control strategies (program control or learner control) and cognitive style with post-task state anxiety.

Hypothesis 2 was tested with a two-way factorial analysis of variance to determine the relationship between post-task state anxiety and treatment condition by cognitive style interaction as reported in Table 4-6. Means and standard deviations for the post-task state anxiety measure by cognitive style are reported in Table 4-4. The two-way analysis of variance reveals no significant difference for the main effect of treatment with an F(1,63) = .048. The main effect of cognitive style was also not significant, F(2,63) = 1.94. For the two-way interaction of treatment by cognitive style strata, no significant differences were reported with an F(2,63) = .074. Therefore, the null hypothesis cannot be rejected for H2 concerning the interaction of control strategy and cognitive style with post-task state anxiety level.

Table 4-6
ANOVA Source Table of Control Strategy and Cognitive Style with Post-Task Anxiety

Source	SS	df	MS	F	Sig of F
Main Effects					
Treatment	5.479	1	5.479	.048	.827
Cognitive Style	442.436	2	221.218	1.94	
2-Way Interaction					
Treatment by Cognitive Style	16.78	2	8.39	.074	.929
Error	7185.426	63	114.054		

H3: There is no significant relationship between pretest scores and posttest achievement scores.

Correlation analysis was used to determine the relationship between posttest achievement and pretest scores. Means and standard deviations for pretest and posttest assessments are reported in Table 4-7. Pearson r correlation index computed was r = .4495, p = .000. Since the p value is less than .05, the relationship is significant between pretest scores and posttest achievement. Therefore, the null hypothesis was rejected.

H4: There is no significant relationship between pre-task state anxiety levels and posttest achievement.

Means and standard deviations for pre-task state anxiety levels are reported in Table 4-4; means and standard deviations for posttest achievement are reported in Table 4-7. Correlation analysis yielded a Pearson r correlation index of r = -.0142, p = .454 for the relationship between pre-task state anxiety levels and posttest achievement. This relationship is not significant, therefore the null hypothesis was not rejected.

Table 4-7
Means and Standard Deviations for Pretest and Posttest Achievement by Control Strategy and Cognitive Style Strata

Control Strategy	Number of Cases	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Learner	35	9.6	2.6	11.5	1.9
Field-D	10	10.2	2.4	11.8	1.5
Field-M	12	8.2	2.4	10.4	2.2
Field-I	13	10.5	2.6	12.3	1.4
Program	34	9.5	2.1	12.0	1.5
Field-D	8	8.8	1.8	11.1	1.6
Field-M	12	9.3	2.4	12.4	1.2
Field-I	14	10.1	2.0	12.2	1.6

H5: There is no significant relationship between locus of instructional control strategy and posttest achievement.

A t-test was used to examine the relationship between treatment condition and posttest achievement. Means and standard deviations for posttest achievement for learner control (N = 35) and program control (N = 34) are reported in Table 4-7. The t-test resulted in a t-value of -1.24 with df = 67 and was not significant. The null hypothesis was not rejected, as there were no significant differences between the two treatment means with regard to posttest achievement.

H6: There is no significant relationship between posttest achievement and the interaction of locus of instructional control strategy and cognitive style.

Two-way analysis of variance was used to examine the relationship between treatment condition and cognitive style on learner achievement. Means and standard deviations for cognitive style and posttest achievement are reported in Table 4-7. The ANOVA demonstrates that there were no significant differences for the main effect of treatment F(1,63) = 1.53. For the main effect of cognitive style (field-dependent, field-moderate, or field-independent), there were no significant differences, F(2,63) = 1.93. However, for the interaction of treatment condition by cognitive style strata, there was a significant difference for posttest achievement with F(2,63) = 4.14, p = .02 as reported in Table 4-8.

Table 4-8
ANOVA Source Table for Control Strategy and Cognitive Style with Posttest Achievement

Source	SS	df	MS	F	Sig of F
Main Effects					
Treatment	4.077	1	4.077	1.53	.220
Strata (CS)	10.272	2	5.136	1.93	.153
2-Way Interaction					
Treatment by Strata (CS)	22.007	2	11.003	4.14	.020
Error	167.435	63	2.658		

To further examine the interaction of treatment condition and cognitive style strata on posttest achievement, t-tests for independent samples were performed for each strata of the treatment conditions. Means and standard deviations for each cognitive style strata for posttest assessment per treatment condition are found in Table 4-7. For field-dependent subjects (N = 18), a comparison of treatment conditions reported a t-value of .89 with df = 16, which was not significant. For subjects in the field-moderate group (N = 24), the t-test was significant reporting a t-value of -2.75 with df = 22. The field-independent subjects (N = 27) yielded a t-value of 0.16 with df = 25, which was not significant. The observed significant interaction of control strategy and cognitive style on learner achievement is a result of the significant difference between control strategies for the field-moderate cognitive style group performance on the posttest. Therefore, the null hypothesis was rejected for H6.

H7: After controlling for pre-task anxiety, there is no significant relationship between posttest achievement and the interaction of cognitive style and locus of instructional control strategy.

To test Hypothesis 7, an analysis of covariance was performed to determine the relationship between cognitive style and treatment condition on posttest achievement with pre-task anxiety as the covariate, as reported in Table 4-9. Means and standard deviations for control strategy and pre-task anxiety are found in Table 4-4; means and standard deviations for control strategy and posttest achievement are reported in Table 4-7. The ANCOVA demonstrates no significant relationship for the covariate, F(1,62) = .015. For the main effects of treatment and cognitive style strata, there were no significant differences, F(1,62) = 1.5 and F(2,62) = 1.9, respectively. For the two-way interaction of treatment condition by cognitive style strata, there is a significant difference after the effects of the covariate are removed, F(2,62) = 4.08, p = .022. For H7, the null hypothesis was rejected. The observed significant interaction of treatment condition and cognitive style on posttest achievement after controlling for pre-task anxiety, results from the significant difference between control strategies for the field-moderate cognitive style group performance on the posttest.

Table 4-9
ANCOVA Source Table of Control Strategy and Posttest Achievement with Pre-Task Anxiety as the Covariate

Source	SS	df	MS	F	Sig of F
Covariate					
Pre-Task Anxiety	.041	1	.041	.015	.902
Main Effects					
Treatment	4.06	1	4.06	1.50	.224
Strata (CS)	10.256	2	5.128	1.90	.158
2-Way Interaction					
Treatment by Strata (CS)	22.054	2	11.027	4.081	.022
Error	167.370	62	2.700		

H8: There is no significant relationship between posttest achievement and the interaction of gender and cognitive style.

To test Hypothesis 8, a two-way analysis of variance was used to determine the relationship between posttest achievement and cognitive style by gender interaction. Means and standard deviations by gender and cognitive style for posttest assessment are found in Table 4-10.

The ANOVA for the main effect of gender was not significant, computing F(1,63) = 2.00, as reported in Table 4-11. For the main effect of cognitive style strata, the F(2,63) = 2.30, was not significant. The two-way interaction of gender by cognitive style strata on posttest achievement was also not significant, F(2,63) = .095. The null hypothesis could not be rejected.

Table 4-10
Means and Standard Deviations by Gender and Cognitive Style for Pretest and Posttest Assessments

Gender	Number of Cases	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Female	31	9.1	2.5	12.0	1.8
Field-D	8	9.3	2.1	12.0	1.4
Field-M	14	8.1	2.7	11.6	2.1
Field-I	9	10.4	2.0	12.6	1.2
Male	38	10.0	2.3	11.6	1.7
Field-D	10	9.8	2.3	11.1	1.7
Field-M	10	9.6	1.8	11.1	1.9
Field-I	18	10.2	2.5	12.1	1.6

Table 4-11
ANOVA Source Table for Gender and Cognitive Style with Posttest Achievement

Source	SS	df	MS	F	Sig of F
Main Effects					
Gender	5.94	1	5.94	2.00	.162
Strata (CS)	13.685	2	6.842	2.30	.108
2-Way Interaction Gender by Strata (CS)	.564	2	.282	.095	.910
Error	187.014	63	2.968		

H9: There is no significant relationship between the interaction of cognitive style and gender on pre-task anxiety.

Two-way analysis of variance was used to determine the relationship between pre-task anxiety and cognitive style by gender interaction. Means and standard deviations for pre-task anxiety by gender and cognitive style are reported in Table 4-12.

Table 4-12
Means and Standard Deviations for State Anxiety Measurement by Cognitive Style and Gender

Gender	Number of Cases	Pre-Task Anxiety Mean	Pre-Task Anxiety SD	Post-Task Anxiety Mean	Post-Task Anxiety SD
Female	31	33.6	9.3	34.0	10.0
Field-D	8	30.9	7.3	31.5	8.8
Field-M	14	35.6	9.4	36.6	10.6
Field-I	9	33.0	10.9	32.1	9.9
Male	38	29.5	9.7	32.5	11.2
Field-D	10	26.9	6.7	28.1	7.8
Field-M	10	30.1	12.7	35.6	15.2
Field-I	18	30.6	9.5	33.2	10.1

The main effect of gender resulted in F(1,63) = 2.73, which was not significant, as reported in Table 4-13. For the main effect of cognitive style strata, F(2,63) = .995, the F ratio was also not significant. The two-way interaction of gender by cognitive style strata resulted in F(2,63) = .158. This interaction was also not significant, therefore the null hypothesis could not be rejected.

Table 4-13
ANOVA Source Table for Gender and Cognitive Style with Pre-Task Anxiety

Source	SS	df	MS	F	Sig of F
Main Effects					
Gender	254.259	1	254.259	2.73	.103
Strata (CS)	185.004	2	92.502	.995	.375
2-Way Interaction Gender by Strata (CS)	29.425	2	14.713	.158	.854
Error	5856.167	63	92.955		

H10: After controlling for GPA, MCAT score, and pre-task anxiety, there is no significant relationship between posttest achievement and the interaction of locus of instructional control strategy and cognitive style.

Two-way analysis of covariance was used to determine the effects of cognitive style and treatment condition on posttest achievement after removing the effects of the covariates, GPA, MCAT score, and pre-task anxiety. Means and standard deviations for cognitive style strata and posttest achievement are reported in Table 4-10; pre-task state anxiety means and standard deviations are reported in Table 4-12. Undergraduate grade point average (GPA) and Medical College Admission Test (MCAT) score means and standard deviations for the treatment groups are reported in Table 4-14.

Table 4-14
Means and Standard Deviations for GPA/MCAT Score by Treatment Condition

Control Strategy	Number of Cases	GPA Mean	GPA SD	MCAT Mean	MCAT SD
Learner	35	3.46	.344	8.41	1.28
Program	34	3.40	.298	8.67	1.68

The two-way analysis of covariance revealed no significant relationship for the covariates, pre-task anxiety (F(1,60) = .031), MCAT score (F(1,60) = .000), or GPA (F(1,60) = .568), with achievement as reported in Table 4-15.

For the main effect of treatment condition, the ANCOVA computed F(1,60) = 1.40. The main effect of cognitive style strata revealed F(2,60) = 2.15. Neither main effect was significant. For the two-way interaction of treatment condition and cognitive style strata, after the effects of the covariates were removed, the F ratio was significant at F(2,60) = 4.48, p = .015. Due to this significance, the null hypothesis was rejected. The significant interaction of control strategy and cognitive style strata on learner achievement, after adjusting for GPA, MCAT score, and pre-task anxiety, results from the significant difference between control strategies for the field-moderate cognitive style group performance on the posttest.

Table 4-15
ANCOVA Source Table for Posttest Assessment by Treatment Condition and Cognitive Style with Pre-Task Anxiety, GPA, and MCAT Score as Covariates

Source	SS	df	MS	F	Sig of F
Covariates					
Pre-Task Anxiety	.085	1	.085	.031	.860
MCAT Score	.001	1	.001	.000	.986
GPA	1.54	1	1.54	.568	.454
Main Effects					
Treatment Condition	3.817	1	3.817	1.40	.240
Strata (CS)	11.691	2	5.846	2.15	.124
2-Way Interaction					
Treatment by Strata (CS)	24.279	2	12.140	4.48	.015
Error	162.544	60	2.709		

H11: After controlling for GPA and MCAT score, there is no significant relationship between pretest anxiety and the interaction of locus of instructional control strategy and cognitive style.

A two-way analysis of covariance was used to determine the effects of treatment condition and cognitive style on pre-task anxiety with GPA and MCAT score as the covariates. Means and standard deviations for pre-task state anxiety levels by treatment condition and cognitive style are reported in Table 4-12. Grade point average and MCAT score means and standard deviations by treatment condition are reported in Table 4-14. The covariates of GPA and MCAT score were not significant, reporting F(1,61) = .296 and F(1,61) = .007, respectively, as listed in Table 4-16. For the main effect of treatment condition, the F ratio was not significant at F(1,61) = .036. The main effect of cognitive style strata reported F(2,61) = 1.22, which was not significant. The two-way interaction of treatment condition by cognitive style strata, after removing the effects of the covariates, reported an F ratio of F(2,61) = .028. This interaction was not significant, therefore the null hypothesis could not be rejected.

H12: There are no significant differences between locus of instructional control strategies in time-on-task to lesson completion.

A t-test was used to examine the relationship between the two treatment means to determine if there were

Table 4-16
ANCOVA Source Table of Pre-Task Anxiety by Treatment Condition and Cognitive Style with GPA and MCAT Score as Covariates

Source	SS	df	MS	F	Sig of F
Covariates					
GPA	29.465	1	29.465	.296	.589
MCAT	.743	1	.743	.007	.931
Main Effects					
Treatment Condition	3.599	1	3.599	.036	.850
Strata (CS)	243.815	2	121.908	1.22	.301
2-Way Interaction					
Treatment Condition by Strata (CS)	5.576	2	2.788	.028	.972
Error	6080.07	61	99.673		

differences in locus of control instructional strategies with regard to time spent to study the lesson. Means and standard deviations for both treatment groups are reported in Table 4-17. The t-test resulted in a t-value of -1.03 with df = 67. This was not significant, therefore the null hypothesis was not rejected.

Table 4-17
Time (In Minutes) to Lesson Completion by Treatment Condition

Control Strategy	Number of Cases	Time to Complete, Mean	Time to Complete, SD
Learner	35	51.48	25.0
Program	34	57.20	21.2

Summary

The results of the data analysis revealed three statistically significant effects. There was a significant effect for occasion for state anxiety level measurement with state anxiety increasing on the post-task measurement after completion of the interactive videodisc lesson. Second, there was a significant relationship between pretest scores and posttest achievement scores. The data analysis also indicated a significant interaction between locus of instructional control strategy and cognitive style on learner achievement. Further analysis of this significant interaction demonstrated that there was a differential effect of instructional control strategy for the three cognitive style stratas. The field-moderate cognitive style strata reveals a significant effect of instructional control, but neither the field-dependent or field-independent stratas exhibit this difference. Further testing with analysis of covariance revealed that even after controlling for pre-task anxiety, GPA, and MCAT score, the relationship remains significant.

Discussion of these findings and implications for instructional technology are presented in Chapter 5. Recommendations for future research are also presented in Chapter 5.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the effects of two locus of instructional control strategies on learner achievement and anxiety as moderated by cognitive style, gender, grade point average (GPA), and Medical College Admission Test (MCAT) score. Two interactive videodisc lessons representing program control and learner control locus of instructional control strategies were used to determine the effects on learner achievement and learner state anxiety levels measured before and after the instructional task.

The study design consisted of a repeated measures analysis of variance experimental design to examine state anxiety changes. Learner achievement was compared using a pretest-posttest experimental design. Analysis of covariance, t-test, and correlation analysis were used to further test relationships between locus of instructional control strategies, learner state anxiety, learner achievement, cognitive style, gender, grade point average (GPA), Medical College Admission Test (MCAT) score, and time-on-task.

Sixty-nine Wayne State University School of Medicine second-year medical students participated in the study. Stratified random sampling was used to sample subjects from three strata determined previously by scores from the Group Embedded Figures Test. Subjects were randomly assigned within strata to one of two treatment conditions, program control or learner control. All subjects completed the interactive videodisc lesson in the Self-Instruction Center of the School of Medicine using a Macintosh IIci computer. The interactive videodisc lesson (software and videodisc) for all subjects contained the same instructional content with modifications in the locus of instructional control. Subjects in the program control treatment condition proceeded throughout the lesson in a predetermined sequence, without control of the lesson, terminating the lesson upon completion of each section and section review, in order. Subjects in the learner control treatment condition were given control of sequencing, need for review, and lesson termination. State anxiety level was measured before and after the interactive videodisc lesson. Also, pretest and posttest assessments measured knowledge of lesson content before and after the interactive videodisc lesson.

Findings

The following hypotheses stated in the operational null form were analyzed using analysis of variance, correlation analysis, analysis of covariance, or t-test.

H1: There is no significant interaction between locus of instructional control strategies (program control or learner control) and occasion (pre-task or post-task) that affects state anxiety levels.

The null hypothesis was not rejected. However, there was a significant increase in subject's state anxiety levels across measurement occasions.

H2: There is no significant relationship between the interaction of locus of instructional control strategies (program control or learner control) and cognitive style with post-task state anxiety.

The null hypothesis was not rejected.

H3: There is no significant relationship between pretest scores and posttest achievement scores.

The null hypothesis was rejected.

H4: There is no significant relationship between pre-task state anxiety levels and posttest achievement.

The null hypothesis was not rejected.

H5: There is no significant relationship between locus of instructional control strategy and posttest achievement.

The null hypothesis was not rejected.

H6: There is no significant relationship between posttest achievement and the interaction of locus of instructional control strategy and cognitive style.

The null hypothesis was rejected.

H7: After controlling for pre-task anxiety, there is no significant relationship between posttest achievement and the interaction of cognitive style and locus of instructional control strategy.

The null hypothesis was rejected.

H8: There is no significant relationship between posttest achievement and the interaction of gender and cognitive style.

The null hypothesis was not rejected.

H9: There is no significant relationship between the interaction of cognitive style and gender on pre-task anxiety.

The null hypothesis was not rejected.

H10: After controlling for GPA, MCAT score, and pre-task anxiety, there is no significant relationship between posttest achievement and the interaction of locus of instructional control strategy and cognitive style.

The null hypothesis was rejected.

H11: After controlling for GPA and MCAT score, there is no significant relationship between pretest anxiety and the interaction of locus of instructional control strategy and cognitive style.

The null hypothesis was not rejected.

H12: There are no significant differences between locus of instructional control strategies in time-on-task to lesson completion.

The null hypothesis was not rejected.

Discussion

Each hypothesis is discussed. Significant findings related to each hypothesis are also discussed.

Instructional Control Strategy and State Anxiety

The data analysis indicated that there was no significant interaction between treatment condition and state anxiety levels across pre-task and post-task measurement occasions. The state anxiety levels of the study subjects were not impacted by the locus of instructional control strategy to which he or she was randomly assigned. The subjects in the learner control group, with control over sequence and pace of instruction, review and lesson termination decisions, had no significant differences in state anxiety levels than did the program control subjects with no control over instructional variables. An extensive review of the literature found no research studies examining interactive video instructional strategies and state anxiety. However, several studies with computer-assisted instruction and state anxiety have reported that providing learners with control of instruction decreases state anxiety (Gallagher, O'Neil, & Dick, 1971; Hansen, 1972; Sieber, O'Neil, & Tobias, 1977). However, Coorough (1990) reports that locus of instructional control strategy may not be an important factor because neither students with high levels of state anxiety nor students with low levels of state anxiety differed in performance. Gallagher, O'Neil, and Dick (1971) conclude that learner control was beneficial in state anxiety reduction for learners with low trait anxiety but not for learners with high trait anxiety. For this study, neither the learner control or program control treatment conditions significantly impacted state anxiety levels. With regard to program design, it appears that medical students do not benefit differentially from learner or program control designs to alleviate or circumvent state anxiety. Medical students are generally disciplined and goal-oriented learners and may approach learning tasks in ways unlike other student populations, quite possibly functioning with higher state anxiety levels in clinical and educational situations.

The data analysis did indicate a significant within subjects effect for measurement occasion of state anxiety levels. The post-task state anxiety levels were significantly increased from the pre-task state anxiety measurement. This finding directly contrasts previous studies examining state anxiety levels and computer-assisted instruction, which found a general reduction in state anxiety levels across measurement occasions (Allen, Gait, & Cherney, 1974; Coorough, 1990; Hansen, 1972). Because state anxiety in medical students using interactive video has not been previously studied, a possible explanation is offered. The lesson content for the interactive videodisc lesson was difficult material in neuroanatomy that had been partially taught the semester prior to this study and material that the students would soon be tested on in the form of state board exams, as required by the medical school curriculum. Upon completion of the neuroanatomy lesson and the posttest assessment, the subjects completed the post-task state anxiety measurement. A majority of subjects (81.2%), indicated that the experience of studying neuroanatomy with interactive video was positive (Table 4-3, Question H); however, many expressed the fear that they had "forgotten most of what I should know from the neuroanatomy course taken as a first-year student." With upcoming board exams, it seems reasonable to contribute the increase in state anxiety after completing the lesson to anxiety over perceived lack of proficiency in the content of the neuroanatomy lesson. Because the treatment condition, program control or learner control, had no positive or negative effects on state anxiety levels, difficult lesson content is a plausible explanation for the increase in state anxiety levels in medical students from pre-task to post-task measurement occasions.

There was no interaction between locus of instructional control strategies (learner control or program control) and occasion (pre-task or post-task) for measurement of state anxiety. The locus of instructional control strategy appears to have no interactive effect with occasion for measurement of state anxiety levels. This finding concurs with previous studies (Coorough, 1990; Judd, Daubek, & O'Neil, 1975) that learner control had no effect on state anxiety levels beyond the effects caused by the imposed program control condition. Further, the program control treatment condition also did not have any effect on state anxiety levels when compared to the learner control condition.

Instructional Control Strategy, Cognitive Style, and State Anxiety

The data analysis indicated that there was no significant relationship for the main effects of treatment condition or cognitive style with state anxiety. Also, the interaction of treatment condition and cognitive style on post-task anxiety was not significant. There were no differences in post-task state anxiety levels for subjects of any cognitive style in either treatment condition. Prior research studies have found significant relationships for instructional control strategy and state anxiety, generally finding that individuals who are made to feel in control tend to be less anxious (Allen, Gait & Cherney, 1974; Stotland & Blumenthal, 1964). For medical students in this study, there appears to be no differences in state anxiety levels after completion of the interactive videodisc lesson for any cognitive style in either treatment condition. Medical students may function with higher state anxiety levels in educational environments due to pressures to excel and succeed.

Learner Achievement

The data analysis revealed a significant relationship between pretest scores and posttest scores following the interactive videodisc instructional control treatment. This finding is consistent with previous interactive video research resulting in a statistically significant relationship between pretest and posttest achievement (Culbert, Cantelmo, Stafford & Allan, 1989; Garrett, Savage, & Hendrickson, 1989; Jones &

Schoultz, 1990). The subject's pretest score appears to be a reliable predictor of posttest performance.

Anxiety and Learner Achievement

Data analysis indicated no significant relationship between learner state anxiety and learner achievement. This finding contrasts several prior studies which have found significant correlations between state anxiety and learner achievement (Pablo, Subira, Martin, Flores, & Valdes, 1990; Raub, 1981; Tyron, 1980). For this study, subjects who were high in state anxiety and subjects who were lower in state anxiety did not differ with regard to learner achievement. State anxiety appears to have no differential effect on learner achievement for urban medical students. Medical students are consistently required to meet high levels of performance in clinical environments and learning environments and may function with high levels of state anxiety as they deal with the pressures of achievement.

Instructional Control Strategy and Learner Achievement

Data analysis indicated that there was no significant relationship between locus of instructional control strategy and posttest achievement. Subjects from the learner control and the program control treatment conditions performed equally well on the posttest assessment. An extensive body of research has found a positive effect on learner achievement if the learner is given instructional control (Campanizzi, 1978; Gray, 1987; Tennyson, Steve, & Boutwell, 1975). However, recent research studies have determined that learner control strategies have no associated achievement gains (Coorough, 1990; Goetzfried & Hannafin, 1985; Milheim & Azbell, 1988). Instructional control strategies have not been previously studied with medical school populations, although this finding supports conclusions that learner control has no significant advantages over program control as instructional control strategies in medical instruction. It is possible that program control subjects reviewed material they were familiar with from a prior neuroanatomy course. The learner control subjects were able to skip familiar material and concentrate on acquiring new knowledge. There may be no achievement advantages to the medical student in reviewing material with which he or she has prior understanding.

Instructional Control Strategy, Cognitive Style, and Learner Achievement

Data analysis reported that the main effects of instructional control strategy and cognitive style on learner achievement were not significant. However, the interaction of treatment condition by cognitive style on learner achievement was significant. This interactive effect of control strategy and cognitive style on learner achievement infers that both independent variables together have an effect on the dependent variable. Prior cognitive style research studies report significant differences in learner achievement for field-independent and field-dependent learners, generally finding superior achievement for field-independent learners in mastering analytical tasks (Adejumo, 1983; Spiro & Tirre, 1980; Witkin, Moore, Goodenough, & Cox, 1977). With interactive video instruction, researchers have found significant effects for cognitive style, primarily higher learner achievement for field-independent learners (Pollack, 1987; Wang 1989). As previously discussed, instructional control strategy as a single independent variable, did not produce a significant effect on learner achievement. To further determine differences for cognitive style and treatment condition on learner achievement, independent sample t-tests revealed a significant differential effect for the cognitive style field-moderate group between instructional control strategies. Neither the field-independent or the field-dependent cognitive style stratas exhibit this difference. The learner control field-moderate cognitive style group (N = 12) with a mean of 10.4 and standard deviation of 2.2 on the posttest assessment was significantly different from the program control field-moderate cognitive style group (N = 12) with a mean of 12.4 and standard deviation of 1.2 for the posttest measurement. Subjects in the program control treatment group performed better on the posttest assessment than did the subjects in the learner control group for the field-moderate cognitive style strata only. The field-moderate cognitive style group was composed of subjects who scored in the middle range of the Group Embedded Figures Test to determine cognitive style, being neither very field-dependent nor very field-independent. Previous research using a field-moderate cognitive style group representing those subjects who score in the middle range of the field-dependence-independence continuum has not been done; however, it is obvious that learner achievement was significantly improved for those subjects in the program control treatment strategy.

State Anxiety, Cognitive Style, Instructional Control Strategy, and Learner Achievement

Data analysis yielded no significant effects for the covariate, pre-task anxiety, or for the main effects, instructional control strategy and cognitive style on learner achievement. However, for the interaction of control strategy by cognitive style, after the effects of pre-task anxiety were statistically controlled, there was a significant effect. Use of the covariate, pre-task anxiety, reduced the within group's variability, against which treatment effects for cognitive style and instructional control strategy were compared. This reflects more precisely the effects of the experimental intervention or instructional control strategy. Several researchers have reported the impact that individual differences have on learner control questions (Klein & Keller, 1983; Strickland, 1989). Cronbach and Snow (1979) have implied that educators can accommodate individual differences such as cognitive style, by altering the interaction the learner has with the instructional process. This finding supports previous research for significant effects for instructional control strategies and cognitive style (Carrier, Davidson, Higson, & Williams, 1984; Fry, 1972) and prior research regarding interactive video, control strategies, and learner achievement (Burwell, 1989; Wang 1989).

Gender, Cognitive Style, and Learner Achievement

Data analysis indicated no significant main effects for gender or the between subjects factor of cognitive style on learner achievement. Also, the interaction of gender and cognitive style on posttest achievement was not significant. Females and males performed equally well on the posttest assessment. Consistent gender differences have been found in the field dependence-independence dimension with field-independent individuals, who were most often male, having greater achievement gains than field-dependent individuals, who were most often female (Coates, Lord, & Jakabovics, 1975; Tegano & Faulkender, 1983).

Cognitive Style, Gender, and State Anxiety

The data analysis reported no significant main effects for gender or cognitive style with pre-task state anxiety. The interaction of gender by cognitive style on pre-task anxiety was also not significant. Female and male scores were not statistically different for the state anxiety pre-task measurement. No significant differences for cognitive style have been reported in other studies as well (Canino & Cicchelli, 1988); however, the majority of cognitive style research has found a significant effect for gender and cognitive style (Doyle, 1975; Newcombe, Bandura, & Taylor, 1983; Tegano & Faulkender, 1983). Few studies have examined cognitive style and anxiety in the academic environment and none have studied these variables with interactive video, and further, no studies have been done with medical student populations.

Locus of Instructional Control Strategy, Anxiety, Cognitive Style, GPA, MCAT Score, and Learner Achievement

Data analysis revealed no significant relationships for the covariates, grade point average, Medical College Admission Test score, and pre-task anxiety. For the main effects of treatment and cognitive style, there were no significant effects on learner achievement. However, for the interaction of instructional control strategy treatment condition and cognitive style on learner achievement, after the effects of the covariates were controlled for, there was a significant effect. This significant interaction is a result of the significant difference between control strategies for the field-moderate cognitive style strata performance on the posttest. Using meaningful covariates, such as pre-task anxiety, GPA, and MCAT score, resulted in a more sensitive statistical test that reduced the error term, allowing for control of relevant individual differences. In this way, a better idea of the true effects of the instructional control strategies emerges. Researchers have reported significant differences for instructional treatments and cognitive style (Smith, 1985), for cognitive style regardless of instructional treatment (Carrier, Davidson, Higson, & Williams, 1984), and no significant differences for either instructional treatment or cognitive style (Canino & Cicchelli, 1988). This study finding, of a significant interaction between instructional treatment and cognitive style on learner achievement when controlling for individual differences, supports Jonassen's (1985) theory that the "most obvious and productive learner characteristic on which to adapt our instruction is the nature of the instructional treatment" (p. 13). Jonassen (1985) further implies that educators can accommodate individual differences such as cognitive style by altering the instructional treatment to enable individuals with different processing capabilities to learn. With regard to interactive video research, this finding supports prior studies reporting significant interactions for cognitive style and instructional control strategies (Burwell, 1991; Hytner, 1987). In the medical student population, the field-moderate cognitive style strata interacts significantly with control strategies causing an effect on achievement of the learner.

Locus of Instructional Control Strategy, Cognitive Style, GPA, MCAT Score, and Anxiety

The data analysis reported no significant differences for the covariates grade point average and Medical College Admission Test score. For the main effects of instructional control strategy and cognitive style, there were no significant effects on pre-task anxiety. The interaction of treatment condition and cognitive style on pre-task anxiety, after controlling for GPA and MCAT score effects, was also not significant. This finding supports conclusions made by Marx, Howard, and Winne (1987) that neither cognitive style nor locus of instructional control are related to cognitive responses to instruction.

Instructional Control Strategy and Time-On-Task

Data analysis reported no significant differences between instructional control strategies and time to lesson completion. Subjects in the learner control treatment condition required no statistically different time-on-task than did the subjects in the program control treatment condition. As discussed previously, there were no significant effects on learner achievement for either instructional control strategy. For medical students, it appears that the learner control strategy yielded comparable achievement with the program control strategy.

Implications of the Study

The results of this study provide several important implications for educational researchers, instructional designers, and medical educators. First, state anxiety does not appear to be an important consideration when determining locus of instructional control and does not seem to affect learner achievement. Although state anxiety did increase over measurement occasions in this study, state anxiety did not inhibit performance. The increase in state anxiety in second-year medical students in this study was attributed to difficult lesson content, a reasonable response for learners in potentially threatening environments. As state anxiety had no discernible effects on learner achievement in either program control or learner control subjects, computer courseware designers and researchers may need to further investigate other individual differences. For medical student populations in urban schools, state anxiety does not appear to be an issue of concern in designing medical education courseware.

Second, this study indicated a significant relationship between pretest scores and posttest achievement. This finding is important for medical educators and for instructional designers. By determining pretest scores, those learners in need of additional instructional support can be identified and opportunities for practice, feedback, and remediation can be incorporated into lesson plans and lesson designs.

The third implication of this study, of importance to educators and instructional designers, is the apparent effect of cognitive style and locus of instructional control on learner achievement after controlling for individual differences such as grade point average, Medical College Admission Test score, and pre-task anxiety. Locus of instructional control did not appear to effect learner achievement, except when interacting with cognitive style. Wapner and Demick (1991) state that there is a sufficient body of empirical research to suggest that field dependence-independence has important educational implications for how students learn, how information is processed, and how instruction is designed. Through instructional design, interactive video is a powerful educational tool capable of providing opportunities to respond to individual differences. As these individual differences form the learner's cognitive system, which in turn guides and aids the learner, instructional designers must incorporate features that assist the cognitive system. Instructional control options, embedded practice questions, immediate feedback, and opportunities for remediation all comprise well-designed courseware (Robyler, 1988). This study finding implies that cognitive style, more specifically, the field dependence-independence dimension, should also be a critical element of the instructional design model. Further, medical educators must begin to recognize the importance of cognitive style, and specifically, the field-moderate cognitive style, and how cognitive style interacts with locus of instructional control when designing and implementing instruction for medical students in the classroom and in self-instruction labs.

Recommendations for Future Study

The results of this experimental study support the need for further investigation of the variables of interest in the study. With regard to locus of instructional control, further research exploring the effects of learner control options is needed to determine how these options relate to individual differences. Also, it is recommended that future research investigate individual differences in specific populations to ascertain what type of student benefits most or least from learner control.

Future experimental studies should examine trait anxiety in medical students and the effect on learning with interactive video. Replication of this study with first-year medical students examining state anxiety is an important issue since the majority of these students would not have experience with interactive video.

With consideration to cognitive style, additional research should explore the efficacy of teaching students cognitive strategies to increase learner achievement. Subsequent research investigating the field-moderate group is essential to discover why this cognitive style strata is different from the field-dependent and field-independent cognitive style groups. Future research should also study the cognitive style dimension in female medical students and the relationship of this group to the cognitive style theoretical framework. Further studies should also explore cognitive style in specific student populations and define interactions with instructional control strategies.

With regard to interactive video, future research inquiries should explore effective instructional design strategies based on the interaction of locus of instructional control strategies and learner attributes. Also, an analysis of interactive video as an advance organizer for difficult lesson content should be judged.

Medical students as a specific population should be studied in future explorations of individual differences to ascertain which attributes of students are most suited to self-instruction with interactive video. Also, it is recommended that research inquiries study internal versus external locus of control and cognitive style in medical students and the impact on learning with instructional technology systems.

Summary of the Study

To contribute to the existing body of research, this study was designed to investigate the effects of cognitive style and locus of instructional control strategies on state anxiety and learner achievement when using an interactive videodisc lesson. Second-year medical students, randomly selected and assigned within cognitive style strata, studied an interactive videodisc lesson in neuroanatomy in one of two treatment conditions, learner control or program control. State anxiety was measured before and after lesson completion; pretest and posttest scores were obtained to measure learner achievement. Results indicated that although state anxiety increased upon completion of the lesson, there were no significant differences for state anxiety with instructional control strategy, cognitive style, learner achievement, or gender. The results of the study found that pretest scores were significantly related to posttest achievement, while there was no relationship between learner achievement with state anxiety, gender, or instructional control strategy. Significant results were found for the interaction of instructional control strategy and cognitive style on learner achievement when controlling for individual differences, specifically, pre-task state anxiety, grade point average, and Medical College Admission Test score.

Locus of instructional control strategies have been studied extensively in the literature, generally supporting learner control as a benefit to the learner (Carrier, Davidson, & Williams, 1985); however, evidence of support for instructional control strategies for differential types of students is conflicting (Hannafin, 1984; Snow, 1980) and has not been studied with medical student populations. Each learner has a preferred method for processing information, known as cognitive style. This preference is a key element in the learning process and may help to predict learner behaviors under different locus of instructional control strategies. Interactive video has the potential to adapt instructional content and mode of presentation to assist in information processing for all types of learners. Medical student populations have not been previously studied with regard to interactive video, cognitive style, instructional control strategies, and state anxiety. This study provides evidence that this population may be different from those previously researched with consideration to these variables. Specifically, state anxiety does not appear to adversely affect learner achievement in urban medical students when learning with computers. Further, consistent gender differences found in the field dependence-independence dimension were nonexistent in the medical student population studied. Additionally, cognitive style and gender seem to have no effect on state anxiety in the urban medical student population studied, contradictory to prior research with other college populations. Also, medical students who are field-moderate, scoring in the middle range of the field dependence-independence continuum, have greater learner achievement with program control when using interactive video. Because interactive video is becoming more readily available in the medical school curriculum and is frequently used by the medical students (32% of the study subjects use interactive video at least once a month, Table 4-3, Question F), it is important to design courseware to meet not only educational needs, but individual needs as well. Medical students are a highly select group of graduate students with unique attributes that present challenging and intricate issues to designers of medical education courseware. Medical students are generally learners who are motivated, disciplined, and goal-oriented, with well-developed cognitive skills. These attributes may have generated a range restriction that influenced the study results. Future studies should examine medical student learner attributes and explore ways to apply this knowledge to benefit educational outcomes. This study supports prior research findings that the interaction of locus of instructional control strategies and learner attributes are critical to learner success in the rich environment provided by innovative educational technology and should be further explored with specific student populations.

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BIOGRAPHICAL SKETCH

Vicki Mari Diaz was born in Marianna, Florida, and lived and attended schools in Chipley, Florida. She graduated from Gulf Coast Community College in Panama City, Florida, with an associate degree in nursing. For several years, she worked as a registered nurse, primarily in trauma and adult health. Later, Vicki returned to school, attending the University of Florida to complete a Bachelor of Science in Nursing degree. Upon completion of this degree, she entered graduate school at the University of Florida, graduating with a Master of Science in Nursing degree with a specialization in adult health. During this time, she worked as a graduate teaching assistant in the College of Health and Human Performance. Determined to realize her educational goals, Vicki began the doctoral program in educational media and instructional design in the College of Education at the University of Florida. While a doctoral student, she worked as a clinical nurse specialist in neurosurgery at the Neuroscience Institute of Santa Fe. During the research phase of her doctoral studies, she moved with her husband, Dr. Fernando Diaz, and daughter, Jaime Anema, to Michigan where her husband became the chairman of the Department of Neurosurgery at Wayne State University. Being a "long-distance" doctoral student was difficult, but she graduated with her Ph.D. in

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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